# Chemistry forensic study cards

Business

FORENSIC CHEMISTRY FORENSIC CHEMISTRY SUMMARY NOTES Ensuring accuracy and contamination of samples for analysis – 1a and 1A | Ensuring accuracy and contamination of samples for analysis – 1a and | | | 1A (continued) | | Caution must be taken by scene investigators with regard to their tools, | | | clothing and evidence storage facilities, since debris can lead to false | All scientific analyses must be accurate and reproducible, hence all | | positive results if it has been contaminated by dirty tools or gloves. instruments used to examine samples must be well calibrated and | | | measurements of standards and controls used to ensure accuracy of | | Discuss the following precautions: | sample analysed.

| | Wearing overalls, hair covering, masks, shoe covers to prevent contamination. | | | Samples placed in sterile sealable bags/containers using sterile forceps. Example: Urine analysis in drug testing: | | Laboratories used for forensic examination must be sterile, with absolutely | | | minimal chance of contamination. | Analytical tools/techniques used must demonstrate excellence. | | A lack of sample security and poor laboratory practices can reduce reliable | All instrumentation must be calibrated and monitored consistently to | | evidence to “ reasonable doubt” | ensure reliability. | | All standards used must be prepared using accurate techniques and | | | controls used and reproduced to ensure consistency.

| | | | | The forensic chemist must verify chain custody for each sample | | | analysis and document the techniques employed and data collected. | | | They must be prepared to defend their work in legal hearings and | | | trials. | Organic and inorganic compounds – 1b | Different classes and tests for carbon compounds – 1c and 1E | | Organic (carbon) compounds are

compounds, which contain mainly carbon and | | | hydrogen, but may also contain smaller quantities of oxygen, nitrogen, sulfur, | Carbon compound class | | phosphorus and other elements. Functional group | | Commonly found or derived from living things: glucose, amino acids, starch and | Distinguishing test | | ethanol. Chemists can also synthesise many organic substances in the | | | laboratories.

alkane | | Inorganic compounds do not contain carbon, except for metallic carbonates, | single bond | | hydrogen carbonates, carbon oxides and carbides. | Add drops of bromine water to sample in the presence of light; very | | | slow reaction. | | | | | alkene | | | double bond | | Add drops of bromine water to sample; rapidly changes bromine from | | | brown to colourless even in the dark. | | | | | alkyne | | | triple bond | | | Add drops of bromine water to sample; slowly changes bromine from | | | brown to colourless even in the dark. | | | | | Different classes and tests for carbon compounds – 1c and 1E. (continued) | Different classes and tests for carbon compounds – 1c and 1E.

| |(continued) | | Carbon compound class | | | Functional group | Acids, bases and neutral salts | | Distinguishing test | | | | Class | | aromatic | Distinguishing test | | benzene ring | Forensic chemistry example | | When drops of bromine water are added to a sample in the presence of light there| | | is no reaction. | Acid | | | pH7 | | alkanoic acid | Cyanoacrylate (superglue) used to reveal fingerprints on glass | |-COOH | surfaces. | | Add drops of aqueous sodium carbonate to sample; bubbles of colourless gas form | | | (CO2). Neutral Salt | | | pH = 6-8 | | ester | Silver nitrate (AgNO3) used to reveal fingerprints on porous | |-COOR | substances. | | Fruity odour; esters

containing four or more carbons are water insoluble. | | | | Inorganic properties of soil and other materials can be useful evidence – 1d | Inorganic properties of soil and other materials can be useful evidence – 1d | | | (continued) | | Soils vary considerably.

The size of soil particles and their chemical | Glass may be useful evidence in a wide variety of cases, for example, | | composition ( clay, silt, sand) can provide very specific location details. | hit-and-run, burglaries and assault. | | Inorganic compounds are important as their composition is rarely altered by | Glass is a hard, brittle, amorphous substance that is composed of silicon oxides | | bacterial action or time. mixed with various metal oxides. Metal oxides include those of Na, Ca, K, Mg, Li,| | Examples of evidence that are composed of inorganic compounds include glass | Ba and B.

| | and soil. Glass may be useful evidence in a wide variety of cases, for | The metal oxides act to modify the properties of the glass. Co, Cr, Mn and Ni are| | example, hit-and-run, burglaries and assault | used to alter the colour of the glass. | | Soils in Eastern Australia often contain relatively high proportions of | The density and refractive index are used to compare glass found at a crime scene| | quartz. | with glass fragments found on a suspect.

| | Both methods require significant statistical treatment to determine the | | | likelihood of the two samples originating from the same source. | | Inorganic properties of soil and other materials can be useful evidence – 1d | Recent example and alteration of an outcome in a forensic investigation – 1e | | (continued) | | | | Case study example | | Paint chips can often provide information to a forensic scientist. | | They can be used to determine if a car

was associated with a particular car | The story | | accident or to associate a criminal with a particular crime scene. | | | Automobile paint contains a pigment and binder, which varies depending on the | In early 2000 in the UK a man was arrested based on his DNA matching that from a | | type of paint. | crime scene. Although he lived over 200km from the site of the crime, the police | | Chips from a vehicle can be traced to particular makes and models using | still believed the DNA result was true and concentrated on this man as their | | techniques such as gas chromatography.

| prime suspect. | Evidence samples can be matched to car manufacturers which use the type of | This man has Parkinson’s disease in its advanced stages and he was unable to | | paint found as evidence and eventually lead to narrowing down the possible | perform simple tasks without help, so his lawyer asked for a more detailed DNA | | suspects or the owner of the vehicle. | test to try to prove that his client was innocent of the crime. The police gave | | | the statistics that there was only 1 in 37 million chance that the man’s DNA was | | | a match for another person’s based on the DNA test that was employed. | | | | | Alteration of the outcome | | | | | The DNA test was a 6-marker test, meaning that six typical base-pair sequences | | | were compared between the two samples.

| | | When the more expensive and time-consuming 10-marker test was performed, it was | | | determined that the man was innocent of the crime. | | | | | The 10-marker test is said to only have a 1 in a billion chance of identifying | | | the person wrongly. | | | | | Recent example and alteration of an outcome in a forensic investigation – 1e | Ethical Issues during analytical investigations – 1B | | | Research these please. | | Breathaliser Example – see

photocopy notes. | | | | Name technology and discuss its advantages over the old technology used to | | | check alcohol levels in drink driving.

| | | Must show a link between the old technology and how the current technology can| | | alter the outcome of an investigation. Use example of a situation. | | | | | | | | | | | | | | | Carbohydrates – 2a | First- hand investigation – Modelling monosaccharides and starch. -2B | | Carbohydrates are compounds that contain carbon, hydrogen and oxygen only. | Research textbooks and Internet resources for the structure of the above | | Monosaccharides (these are the basic building blocks of more complex carbohydrates). | carbohydrates.

| | Examples include glucose and fructose. Disaccharides (molecules of these contain two | Construct 3D models of glucose, fructose and starch using molecular modelling | | monosaccharide units linked together). Sucrose (cane sugar or table sugar) is an example. | kits. | | Polysaccharides (molecules of these are polymers made up of long chains of monosaccharide | Glucose units are linked correctly through a condensation polymerisation | | units). Examples include celluloses, starches and glycogen.

| reaction (elimination of water). | | | Class linked glucose units to construct a long coiled structure of starch. | Glucose is a monomer – 2b | Plant and animal carbohydrates -2d | | When two monosaccharides (monomer units) combine a disaccharide is formed. The reaction is | | | called a condensation reaction, resulting in the elimination of a water molecule. Sucrose is | Carb | | a dissacharide, which is formed by linking glucose and fructose together, eliminating water. | Origin | | Polysaccharides are formed when many

monosaccharides are linked together in a condensation | Composition | | reaction.

Cellulose (unbranched molecules), starch and glycogen (highly branched molecule) | Found in | | are all polysaccharides formed from glucose monomer units. | | | Soluble starch is called amylose (unbranched-chain molecule); insoluble starch is called | Cellulose | | amylopectin (branched-chain molecule). | Plant | | | Linked (-glucose monomer units. Straight chained water insoluble fibres. | | | Plant cell walls | | | | | | Starch | | | Plant | | | Linked (-glucose monomer units. Coiled structure | | | Stored in cytoplasm of cells | | | | | | Glycogen | | | Animal | | | Linked ( -glucose monomer units.

Highly branched and coiled. | | Stored in muscle and liver cells | | | | | Reducing and non-reducing sugars-2c | glucose | | Reducing sugars (monosaccharides, e. g. glucose and some disaccharides, e. g. lactose and | | | maltose) Reducing sugars have an OH, attached to the C that the O in the ring is attached | | | to.

The chain can flip open to a straight chain structure and expose the –CHO group. It is | | | this aldehyde (alkanal) group -CHO which is oxidized to -COOH group by the addition of extra| | | oxygen. | | | The Cu2+ in the Benedict’s reagent (deep blue Copper sulfate alkaline (NaOH) solution)) are | | | reduced to Cu+1. This is seen from the colour change from light blue to brick orange colour | | | when gently heated. | | Non-reducing sugars do not have the –CHO group and do not reduce the copper ions. | | | Risk Assessment: | | | NaOH is corrosive.

Wear safety glasses to ensure no burns to eyes and when heating ensure | | | that the open end test tube is facing away from any persons to ensure no burns to any parts | | | of the body. | |[pic] | | | Glycogen is similar to the amylopectin (insoluble starch) however it has more side chains | | |(highly branched) | | | | Starch | | Proteins for structure and enzymes –3a | Composition of amino acids and proteins – 3c | | There are two general classes of protein – Fibrous and globular. | | | Fibrous proteins are tough, stringy in appearance and are insoluble in most | Amino acids are compounds that contain both an amine and a carboxylic acid | | solvents. Fibrous proteins form the major structural component of animal | functional group. | | tissue. They are found in skin, hair, muscles, tendons and supporting tissue.

R | | Globular proteins are predominately spherical in shape and are soluble in | | | water. They have specialised functions such as oxygen carriers (in | General formula of amino acids is: H2N-CH-COOH | | haemoglobin) communication agents (in nerve cells) defence agents (in | The COOH group being acidic tends to lose a proton, while the amine group NH2 | | antibodies) biochemical catalysts (in enzymes). | being basic tends to gain a proton. Hence in solution amino acids exist as | | | dipolar ions (zwitter ions) | | | | | R R | | | H2N-CH-COOH ( +H3N CH-COO- | | | Proteins are long-chain molecules with thousands of amino acid molecules joined| | | together. | | | Protein structure- refer to Powerpoint on moodle (primary, secondary and | | | tertiary protein structure) | | Major functional groups in an amino acid – 3b | Peptide bond-3d | | The major functional groups present in an amino acid are: | | | Amino group (-NH2). At least one amino group is required to give the

amino | Proteins are made by the linking of amino acids and the main links are called | | acid some basic (alkaline) properties | peptide bonds.

This linkage involves a condensation reaction between the COOH | | Carboxylic acid group (-COOH). At least one carboxylic group is required to | of one amino acid and the NH2 of another with the elimination of a water | | give the amino acid some acidic properties. | molecule. | | | A covalent C-N bond is produced from the peptide linkage. | | Proteins can be broken (hydrolysed) at different lengths in the chain by choice| | | of enzymes.

This occurs in digestion, both in stomach and in the intestine. | | | Some enzymes are very specific as to which peptide bonds they will break. | | | By using particular enzymes it is possible to break a protein in to several | | | smaller polypeptides. | | | | | | | | First hand investigation – Test for proteins-3B | Chromatography and electrophoresis processes compared –3e | | | Similarities | | Chemical | Differences | | Reagent | | | Positive result | Both separate mixtures of amino acids | | | Chromatography separates amino acids on the basis of their solubilities in | | Protein | polar and non-polar solvents. | | BIURET | | |(1ml NaOH solution, then a few drops of CuSO4 solution) | Both powerful tools for forensic chemists in identifying amino acids present in| | Colour change from blue to purple.

| a mixture. NOTE: This is not a process however useful for assessing these | | | techniques in forensic investigations) | | | Electrophoresis separates amino acids based on their charge and size. | | Risk Assessment | | | | | NaOH is corrosive. Safety glasses are worn to prevent burns to eyes. | Electrophoresis allows the separation of certain amino acids by changing the pH| |(Dropper

bottles were used to ensure confinement of chemical and small amounts| of the solution. More effective.

| | of chemical used. | | | | | | In chromatography, while changing the solvent gives some control over the | | | degree of separation it is less effective. | | | | | Origins of a protein in forensic investigations-3f | First hand Investigation – Modelling proteins-3A | | Electrophoresis is widely ised in the separation of biological | Using molecular modelling kits it is possible to simulate the | | molecules such as proteins and DNA. It can separate individual | formation of a peptide bond and hence the formation pf a | | amino acids within a protein and hence allow the protein itself| polypeptide chain (proteins). | | to be determined. | From this we can determine the composition of proteins and its | | The proteins present on the surface of a red blood cell | generalised structure.

| | determine human blood groups (A, B, AB and O). Electrophoresis | Advantages of modelling: Allows a 3D representation of protein | | of a blood sample identifies the amino acids, and therefore the| structure. Hands on learning and experimenting. Simplifies a | | protein and thus the blood group of the sample. This process | complex process of polypeptide formation. | can be used as collaborative evidence by a forensic chemist to | Disadvantages of modelling – Does not show electrons shared.

| | link or dismiss a suspect to a crime. This method may also be | This is illustrated by plastic bonds. Not to scale. Does not | | used to help identify a victim of a crime or solve paternity | show the involvement of enzymes in protein | | cases. | synthesis/hyrdolysis.

| | First hand investigation –Chromatography -3C | First hand investigation – Chromatography and solvent | | Stationary phase – absorbent paper (filter paper) | polarities. –3D | | Mobile Phase – liquid (solvent). A more accurate determination of pigments in a sample can be | | Substance (plant pigment) to be separated is loaded about about| done by using solvents with different polarities (non | | 2cm above the bottom of the paper. This position is called the | polar/polar solvents). | | origin.

| Examples of polar solvents include: water, acetone, ethanol. | | The paper is then placed in a container so that the solvent is | Examples of non-polar solvents include: kerosine, turpentine. | | below the dot (origin). As the solvent rises up the paper, the | If a plant sample contains polar and non-polar pigments then | | components of each sample separate. The rate at which the | the separation of the pigments can be improved by altering the | | components are carried up the paper is dependent on the degree | solvent used.

Eg. Use a polar solvent to separate the polar | | to which the pigment is soluble in a solvent and the degree to | pigments and then repeat the process with the non-polar | | which the pigment adheres to the paper. | solvent to separate the non-polar pigments. | | A pencil line is drawn about 1cm below the top of the paper | | |(solvent front) and process stopped once the solvent reaches | | | the solvent front. | | Paper is dried and components identified by coparison to a | | | control sample.

| | | Refer to Conquering Chemistry text page 478 | | | First-hand investigation – electrophoresis – 3E | Structure and composition of DNA –4a |

| Refer to internet simulation. | Deoxyribonucleic acid is found in the nucleus of all living | | Electrophoresis is the separation ofmMolecules to be separated | things. | are applied to a supporting media (agar gel, cellulose acetate | Contains four bases: adenine, guanine, cytosine, thymine. | | or paper. | DNA is composed of two strands colied (double helix) in which | | Most biological molecules are electrically charged, move in an | each strand is composed of linked sugar and phosphate groups | | electric field when current is applied. |(backbone).

| | At low pH they have a net positive charge and will move towards| A base is attached to each sugar in the strand. A-T and C-G are| | the negative electrode. | the complimentary base pairs. | | At high pH, they have a net negative charge and will move | Between an A and T there are 3 hydrogen bonds. Between C and a | | towards the positive electrode. G there are 2 hydrogen bonds which hold the two strands | | The isolectric point is the pH at which there is no electric | together.

| | charge on the molecule. Different molecules differ greatly in | See pictures in Conquering Chemistry: ph 484-486. | | their isoelectric points, so they will migrate at different | | | rates at a particular pH. | | | Anaysis of DNA and identification of individuals – 4b | Draw and label an example of a nucleotide sequence | | DNA is unique to each individual (except for identical twins. | | | It is independent of the organisms’s age and tissue.

Every cell| | | contains DNA. | | | DNA is a robust molecule hence does not degrade rapidly so | | | sample can be preserved. | | | It has high analytical sensitivity and therefore requires only | | | minute samples for analysis. | |

Individuals can be identified by analysing the non-coding | | |(introns) sequences along the DNA strand which vary | | | significantly from person to person. (more in point 4c) | | | Processes in DNA analysis for individuals/relationships | Processes in DNA analysis for individuals/relationships | | between people –4c | between people –4c | | Steps in DNA analysis: Steps in DNA analysis: CONTINUED | | 1) Separate the DNA from other material in the sample.

Usually | 3) This process is repeated for about 25 cycles to amplify the | | done by soaking the sample in a mixture of water-saturated | original DNA strand. | | phenol and water. The DNA dissolves in the water layer from | 4)Restriction enzymes are then added which cut the DNA strand | | which it can then be recovered. | in to a series of fragments of various sizes. | | 2) Make multiple copies of selected segments of the DNA in | 5) Determine the length (number of nucleotides or bases) of | | intron regions using the polymerase chain reaction method | these copied segments by electrophoresis. | |(PCR).

6) Compare samples from different sources or persons to see if | | This is usually done by separating the DNA double strand in to | they match. (Re-visit the electrophoresis internet simulation | | single stands through incubation at 94(C. | activity). | | Short pieces of purified DNA called primers are added which | | | bond to the DNA at lower temperatures. An enzyme is then added | | |(DNA polymerase) which causes the primers to synthesise | | | complimentary strands of each single strand. | | Range of uses of DNA analysis and ethics in DNA data banks – 4A| Range of uses of DNA analysis and ethics in DNA data banks – 4A| | Range of uses in DNA analysis |

(continued) | | Identifying the person who produced a biological sample at a | Points For | | crime scene: typical samples are blood, sperm, saliva, skin and | Fingerprints from crime scenes can be compared to stored prints| | hair with blood or saliva prefered.

| in an attempt to identify a culprit. | | Identifying the father of a child in disputed paternity cases | Apowerful tool in identifying criminals. | | Establishing familial links when there is a need to erify the | Innocent people currently are incarcerated for crimes they did | | claim of one person to be a relative of another person. | not commit; if samples had been taken at the time of arrest, | | | these individuals would have been excluded early in the | | | investigative process. | | | Investigators would be able to compare other cases against the | | | arrested person’s DNA profile, just as with fingerprints. | Range of uses of DNA analysis and ethics in DNA data banks – 4A| Range of uses of DNA analysis and ethics in DNA data banks – 4A| |(continued) | (continued) | | Points Against | | | Opposition from civil liberties groups to widespread | The primary concern is privacy.

| | fingerprinting of populations | DNA profiles are different from fingerprints, which are useful | | Breach of individuals privacy | only for identification. | Possibilities of insurance companies demanding routine | DNA can provide insights into many intimate aspects of a person| | screening of such material and getting access to information | and their families including susceptibility to particular | | about genetic disorders could seriously disadvantage affected | diseases, legitimacy of birth, and perhaps predispositions to | | people when seeking insurance. | certain behaviours and sexual orientation. | | | This increases the potential for genetic discrimination by | | | government,

insurers, employers, schools, banks, and others. | Destructive testing – 5a | Evidence about samples using analytical techniques – 5A | | If the original sample is modified in some way and/or not | Analytical techniques may be useful in the following ways: | | recoverable, the analysis is called a destructive analysis. | Analysis of organic compounds such as oil spills which enables | | Non destructive testing is required in cases such as: | the scientists to trace the origin of an oil spill in the | | identification of artworks or establishing the authenticity of | ocean.

| | historical artefacts. Therfore forensic scientists are often | Drug testing in biological samples such as urine/blood samples | | not allowed to carry out a destructive test. Ink testing in forged bank notes | | This can be a problem for a forensic scientist for the | Analysis of poisons in autopsy investigations | | following reasons: | Pharmaceutical analysis | | Very small samples are present and repeats of tests are | Cosmetic, explosives, soft drinks, herbicides and drinking | | necessary. | water analysis. | | The requirement of non-destructive testing.

| | | Examples of destructive analysis include instruments such as: | | | mass spectrometry and analytical techniques such as gas/liquid | | | chromatography, atomic absorption spectroscopy and high | | | performance liquid chromatography. | | Gas-liquid and high performance liquid chromatography – 5b | Gas-liquid and high performance liquid chromatography – 5b | |(continued) |(continued) | | Gas chromatography permits the rapid separation of complex | GC is a technique for separating substances based on their | | mixtures in to individual compounds (like organic compounds) , | differential distribution between two phases, one

stationary | | and allows qualitative and quantitative determination of each | and the other mobile. | | compound. | In GC a coiled tube is packed with a particles coated in | | This technique is extremely sensitive and can detect minute | silicone oil (high BP) and a tiny sample of the material to be | | quantities of a compound. It is used in conjunction with mass | analysed is injected in to the tube and vapourised. A gas such | | spectroscopy to detect the presence of analgesics, narcotics, | as nitrogen is pumped through the tube and the components are | | anabolic steroids, stimulants, diuretics in urine samples | separated as the gas pushes them through the tube.

| | provided by athletes. | Detection is performed by a flame ioniser. | | A common application of GC in forensic chemistry is measuring | | | the blood alcohol (ethanol) level of drivers. It gives fast and| Refer to flowchart diagrams of Gc in your forensics booklets. | | accurate results.

| | Refer to Forensic Chemistry notes booklet for a detailed | | | assessment. | | | Gas-liquid and high performance liquid chromatography – 5b | Gas-liquid and high performance liquid chromatography – 5b | | HPLC allows sensitive analysis of a wide range of compounds and|(continued) | | is widely used for pharmaceutical analysis. It allows | This method uses a small-diameter steel tube as the column, | | qualitative and quantitative determination of each compound | packed with a finely powdered medium. The solvent is pumped | | HPLC is fast, accurate and can measure the quantity of | through at high pressure which increases the flow rate. | | compounds as little as ppm and ppb.

It can yield highly | It can be carried out at elevated temperatures to enhance the | | reproducible results and it is non-destructive. Hence it is a | separation. | | very sensitive and useful analytical tool. | Detection and measurement of the concentrations is by a UV | | | spectrophotometer and the results are graphed. | | Refer to Forensic Chemistry notes booklet for a detailed | Refer to flowchart diagrams of HPLC in your forensics booklets. | | assessment.

| | | | | | | | | | | | | Mass Spectrometer – 5c . Refer to interactive internet activity | Mass Spectrometer – 5c (continued) | | sheet on mass spectrometer. | Negatively charged accelerator plates accelerate the positively| | How it Works! | charged ions through the mass spectrometer. The result is a | | Compound to be analysed is uasually dissolved in a common | rapidly travelling ion beam. | | volatile solvent | Ions then pass through a perpendicular magnetic field.

The | | The syringe introduces the sample to the mass spectrometer. | field causes the ions to move in curved paths with a radius | | The vaporisation chamber which is heated to extremely high | dependent on the mass-to-charge ratio of the ions. Only ions | | temperatures vaporises the sample introduced. | with a particular radius reach the collector. By changing the | | The vaporised molecule is then hit with high energy electrons.

electric or magnetic field, different masses can reach the | | The molecule can either lose an electron to become a radical | collector. | | cation, or it can absorb an electron to become a radical anion | The detector identifies the mass of each particle from its | | or there may be no reaction. | path. The

data are recorded as a mass spectrum. | | | | Mass Spectrometer – 5c (continued) | 5c – (continued) It is used in conjunction with GC in | | Use for forensic chemists | identifying accidental or deliberate oil spills. Samples from | | A mass spectrometer is widely used to determine relative | oil spills can be analysed and compared to those stored in the | | molecular masses of compounds, identify a range of industrial,| computer library to identify the source of the oil and hence | | environmental and forensic samples by comparison with standard | the ship responsible for the spill.

| | spectra (fingerprinting) and determine structural information | The combination of GC and MS enables forensic toxologists to | | about new compounds. | separate components of a drug mixture, and provides for the | | | specific identification of a drug substance. | | Conditions under which atoms emit light – 6a | Emission of quanta = specific colour – 6b | | Atoms in their normal state do not emit light. [pic] | | When atoms are given extra energy, either by being heated to a | | | high temperature or by being placed in an electric discharge, | | | they can be made to emit light. This is the basis of atomic | | | emission spectroscopy. | | | When atoms are given extra energy their electrons become | | | excited and move to a higher energy level.

When they drop down | | | to their ground state at a lower energy level (nomal state) | | | light is emitted. | | Emission of quanta = specific colour – 6b continued | Certain wavelengths of light are abosrbed – 6c | | White light is the combination of all colours of the spectrum. | Each individual excited atom usually emits only one wavelength. | | The spectrum ranges from 375nm (violet) to 740nm (red). The | Not all atoms in a sample will absorb or

be excited in exactly | | spectrum can be split into three basic sections Ultraviolet | the same way and therefore excited electrons will travel to | | light (740nm). | ground state).

| | Each colour corresponds to a wavelength. Red colour has a | Each element produces a different wavelength of light (colour) | | longer wavelength than blue colour. | because each element has a unique energy level system (energy | | The wavelength is inversely proportional to the amount of | shell spacing). Therefore when an atom is excited, electrons | | energy released. This means that as the amount of energy | will travel to different shells according to the element. | | released decreases the wavelength increases.

Less energy is | | | required to produce a red colour (longer wavelength) than blue | | | colour. | | | | Signature line emission spectrum – 6d | Use of emission spectra in identifying elements in chemicals – | | Since each element has a unique combination of colour | 6e | | wavelengths produced by the electrons release of energy, a | Emission spectra can be used in the identification and analysis| | specific series of lines are formed. The series of lines are | of many elements particularly metals. It can be used in the | | called a spectrum. A spectrum formed by the emission of energy | following invesdtigations: | | is called an emission spectrum unique to that element.

| Lead poisoning investigations, | | | Water quality analysis for toxic metals or in water supply | | | control. | | Identification of particular elements in stars, | | | Soil detection to establish the origin of the soil sample. | | | Steel industry to monitor compositions of steels as they were | | | being made. | | First hand investigation – Emission spectrum of Na and Hg – 6A | Origins of a mixture

and emission spectra – 6B | | Gas discharge tubes were used and hand held spectroscopes to | | | view the emisison sectra of Na and Hg. Practice exam style questions on identifying elements from | | Electrical energy is used to excite the atoms in the tube, | emission spectra. Refer to exercises in Conquering chemistry | | producing a distinctive colour light for each element.

A hand | text book pages 509-511. | | held spectroscope is used to observe the spectrum for each | | | element. | Emission spectra can be a valuable technique in forensic | | Ensure room is dark to ensure no other light source is present | investigations as it can determine the origin of metal elements| | which would interfere with the element’s spectrum studied. This| found in crime scene samples such as sand samples for example. | | would give invalid results.

Sand composition varies from place to place and if soil | | Gather first-hand information and draw to scale the spectra of | evidence is analysed the forensic scientist can determine the | | individual elements including Na and Hg. | origin of the sample and hence link the evidence to a | | Use second-hand information such as posters/textbook pictures | particular geographical location. | |(reference mateerial) of elemental emission spectra to compare | | | class results. | Refer to point 6e for other examples and expand on them. | | Refer to your prac handout for your results. | | ————————– OH group is now part of the glycosidic bond.

No reaction occurs. Can flip open and be oxidised to an alkanoic acid.