

		<b>Marks</b>
<b>Question 32 — Forensic Chemistry (25 marks)</b>		
(a)	(i) Identify the functional group in glycerol.	<b>1</b>
	(ii) Compare the reactions of both glycerol and 1-propanol when they react with cold dilute $\text{KMnO}_4$ .	<b>3</b>
(b)	Discuss the value of electron spectroscopy and scanning tunnelling microscopy in the analysis of small samples in forensic chemistry.	<b>4</b>
(c)	(i) What class of compounds is used to break proteins into fragments of different lengths?	<b>1</b>
	(ii) Describe the processes of electrophoresis and chromatography in separating organic compounds.	<b>4</b>
(d)	During your practical work you performed a first-hand investigation to describe the emission spectrum of sodium.	
	(i) Name the piece of equipment you used to analyse the emission spectrum of sodium in the laboratory.	<b>1</b>
	(ii) Outline the procedure that you used in this investigation.	<b>2</b>
	(iii) Explain how the emission spectrum was produced.	<b>3</b>
(e)	Discuss the uses of DNA analysis in forensic chemistry.	<b>6</b>

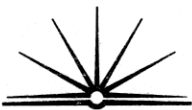
**End of paper**



a) i)  $-OH$  = alcohol group. / Hydroxy group

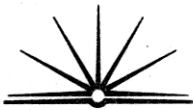
ii) <sup>cold dilute</sup>  $KMnO_4$  reacts with 1-propanol to produce propanoic acid. <sup>cold dilute</sup>  $KMnO_4$  reacts with glycerol to produce  $3CO_2$ . Due to the fact that glycerol is a triol (has 3  $OH$ ) it requires more  $KMnO_4$  for a reaction to occur than 1-propanol <sup>to oxidise all the  $OH$ 's.</sup> does. Both reactions decolourise the purple  $KMnO_4$ . but 1-propanol does it ~~quicker~~, requiring less amount of  $KMnO_4$  than glycerol. due to the fact 1-propanol has only 1  $OH$  & glycerol has 3.

b) Electron Spectroscopy for chemical analysis (ESCA) is a surface analysis technique used to find the elemental composition of the surface layer of a solid. An x-ray beam is focused onto the sample causing electrons to be emitted. An electrostatic analyser measures the kinetic energies of the electrons & converts them to binding energies enabling



elemental identification. As it is a surface analysis technique, it allows forensic chemists to identify the nature of a stain or deposit (on a skirt, table top etc) & match it to a suspect. However, this inhibits it from detecting things below the surface which could be invaluable if stains overlap. It can help forensic chemists understand the nature of weathering or corrosion a piece of evidence has experienced (ie. automobile part) & allow them to ~~place~~<sup>trace</sup> a suspect or place found a specific location. It only requires small samples which is beneficial as often forensic chemists are only given a small amount of evidence. Although, as it causes electrons to leave the sample it can destroy the sample prohibiting its use for further testing to validate results.

~~The sample must~~ limitation, also include it must be clean & free of high pressure contaminants, & it is very sensitive & expensive.



Scanning tunnelling Microscopy - ~~is similar to~~ <sup>Producing an</sup>  
accurate 3D image of the surface of  
solids allowing forensic chemists to  
obtain information about the irregularities  
in the surface. It's like AFM in that it  
uses a fine tip to scan the surface  
however a voltage is applied. This  
voltage causes electrons to leave surface &  
jump to tip of needle, thus is a  
destructive technique & wouldn't allow  
further testing if it was required. It  
only needs a small sample which, like  
EDX, is good to forensic chemist who only  
get a small sample. The substance must be  
conducting or semi-conducting, which is  
invaluable as only some substances can be  
analysed. It must be a clean ~~of~~ sample.  
As it provides forensic chemists with  
topographical images, it aids them in  
controlling/improving environment &  
policing environmental legislation. These both  
techniques are of high value to the forensic chemist  
helping them to analyse evidence to be cases.



e) i) Enzymes

ii) Paper electrophoresis:

A paper soaked in a buffer of pre-determined pH serves as a bridge between 2 electrode vessels. Next, an amino acid <sup>(organic material = whatever it may be)</sup> is applied as a spot. When current is applied, the amino acids <sup>(for whatever organic material it is)</sup> move to the electrode with a charge opposite to their own. Molecules having ~~large~~ high ~~elect~~ <sup>charge</sup> density move faster than those with a low charge density. Those already at their isoelectric point stay at origin. When electrophoresis separation is complete, the paper is dried & dyed (Ninhydrin) which makes the separated amino acids visible.

Electrophoresis separates on the differences in size & charge. A can be used <sup>not only on</sup> ~~as a~~ amino acids ~~but also on~~ <sup>but on</sup> organic material also.

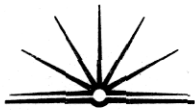
Chromatography is the process of separating organic compounds on the basis of their differential distribution in 2 phases = 1 stationary, & one mobile. It separates them according to their different solubilities in different solvents.

e.g. separating pigments in eucalyptus leaves.

- leaves are crushed in a mortar with a pinch of sand & Methylated spirits
- Then <sup>they are</sup> filtered into a beaker.

- A drop of the <sup>filtered</sup> solution is applied to chromatography paper & placed in a test tube containing 1cm of methylated spirits.

- The paper is left & the pigments move up the paper according to their different solubilities.



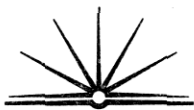
d/ i) Platinum wire, Bunsen burner,  
Spectroscope.

ii) - Clean the platinum wire by placing in  
the burner.

- Place a small amount of Na on  
the wire & place in burner flame.

- View through a spectroscope.

iii) Each element has its own electron  
configuration, which sets out the positions of  
its electrons around the nucleus in shells at  
fixed positions to a stable atom. When an  
element is excited (by placing in an  
electrical discharge or ~~as~~ in our case by ~~the~~  
heating) <sup>it jumps</sup> into a higher energy level; that is  
a shell further away from the nucleus. ~~It~~  
~~emits electromagnetic radiation that can be~~  
~~observed by human.~~



emits ~~at~~ a wavelength of light. Each line in the emission spectrum

The electron is unstable in its new position & so it "falls back" to its ground state position emitting the absorbed photon of energy as it does so. Each line in the emission spectrum indicates a transition from one energy level to another. Na produce an intense yellow colour.

e) DNA analysis is widely used in forensic chemistry to identify relationships between people, to identify individuals, to convict criminals as well as to alter the outcomes of an investigation.

~~Each~~ DNA analysis can be used to identify relationships between people. Each individual's DNA is unique. There is no relationship between the ~~genetic~~ ~~conventional~~ fingerprint of a child & a parent. However,





there is a relationship between a person's genetic fingerprint with that of their parents as a child receives half their genetic make up from each parent. Thus, <sup>correlating</sup> ~~a relationship~~ of DNA can be used to ~~to~~ determine paternity. Brothers & sisters have 50% of their introns (non-coding sequences in DNA which makes DNA unique to each individual) in common & cousins 25%. ~~Identical twins~~ ~~Identical twins~~ ~~Identical twins~~ ~~Identical twins~~ have identical ~~genetic~~ DNA fingerprints. Thus, DNA analysis can be effective in identifying relationships between people, as those unrelated have no DNA the same.

Each individual has unique DNA due to non-coding sequences (introns) that are different in each individual. Human chromosomes contain many repeats of short sequences of bases. The length of these ~~repeats~~ sequences & <sup>no. of repeats</sup> vary in each individual. They can be ~~replicated~~ ~~by~~ ~~electrophoresis~~ replicated by polymerase chain reaction



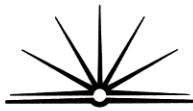
& then cut by restriction enzymes, separated by electrophoresis & ~~then~~ used to identify individuals (possibly criminals) by collecting DNA samples <sup>to fact that only small samples are needed forensic chemists who are only provided with small pieces of evidence.</sup>

~~DNA analysis can also be used to~~

~~with~~ Noting the fact that DNA analysis can <sup>identify</sup> ~~identify~~ individuals, it can <sup>therefore</sup> be used to convict criminals, if their DNA is found at a crime scene. However, this would rely on all suspects being willing to take a DNA test seen as DNA

Databanks have not yet been established for such use due to ~~debate~~ controversial issues such as the right of an individual to privacy. \* (please turn over here) →

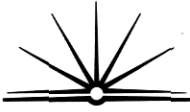
DNA analysis can also be used today to alter the outcomes of forensic investigations of, the post- this is evident in the article from the SMH on 28/8/02 "After 17 yrs, DNA frees man who confessed to murder." The article tells the story of a man, also in 1984



Confessed to the rape & murder of a young girl. In recent times, the evidence; a bottle & underwear used to strangle the victim, were analysed using DNA fingerprinting - when originally there was no method to identify an individual through DNA. The DNA analysis showed that the ~~man~~ convicted ~~man's~~ DNA did not match that on the evidence & he was released. <sup>QPTO.</sup>

~~QPTO.~~

← ~~QPTO.~~ However, due to the fact that ~~identical individuals~~ <sup>identical</sup> have ~~a~~ identical DNA fingerprints, in an extreme case, a twin may be convicted of a crime that their sibling has committed. For this reason DNA evidence must not & cannot be solely used ~~to~~ in forensic chemistry & DNA analysis/evidence must be used in conjunction with other chemical tests to ensure accuracy of results & forensic investigation outcomes.



Therefore, it is evident that DNA analysis plays a major role in Forensic chemistry & is of great significance to the forensic chemist in analysing evidence & reaching conclusions. However as stated above, it should never be used on its own in order to ensure accuracy & reliability of results in criminal cases.