Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Science

End Sem Examination May-2024

FS3CO09 Forensic Chemistry

Programme: B.Sc. (Hons.) Branch/Specialisation: Forensic Science

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. Ethanol is absorbed in the blood from- **1**

(a) Stomach only

(b) Stomach and small intestine

(c) Small intestine and large intestine

(d) Kidney and liver

ii. The enzyme present in the liver which metabolizes alcohol is called as- **1**

(a) Alcohol peroxidase (b) Alcohol dehydrogenase

(c) Alcohol phosphatase (d) Alcohol esterase

iii. Prior to the enactment of the Narcotic Drugs and Psychotropic Substances Act, 1985. Which of the following was not an act- **1**

(a) The Opium Act, 1857

(b) The Opium Act, 1878

(c) The Dangerous Drugs Act, 1930

(d) The Cocaine drug Act, 1875

iv. Which of the following are depressant? **1**

(a) Barbiturates (b) Tranquilizers

(c) Both (a) and (b) (d) Heroin

v. An example for non pyrolizable solid fuel- **1**

(a) Wood (b) Paper

(c) Charcoal (d) Accelerant

vi. The pattern resulting from an ignitable liquid trailer is often called a _____ pattern. **1**
(a) Burn patter (b) Pour pattern
(c) Drop down pattern (d) V Pattern

vii. The best containers for collection of liquid accelerants. **1**
(a) Unused Metal Cans (b) Anti-Static bags
(c) Polythene bags (d) Glass jars

viii. Distillation tends to favor separation of ____ boiling point petroleum compounds. **1**
(a) Higher (b) Lower
(c) Both (a) and (b) (d) None of these

ix. Instantaneous disintegration of explosive molecules is- **1**
(a) Detonation (b) Deflagration
(c) Combustion (d) Hydrolysis

x. ANFO stands for- **1**
(a) Ammonium nitrate fuel oil
(b) Arsenic nitrate fuel oil
(c) Ammonium nitric acid fuel oil
(d) Ammonia nitrate fuel oil

Q.2 i. Distinguish between illicit liquor and country made liquors in India. **2**
ii. Explain the metabolism of alcohol as soon as it enters the body. **3**
iii. Elaborate in detail the analysis of methyl alcohol in the laboratory. **5**
OR iv. What do you understand by alcohol gaze nystagmus? Write the physiological effect of alcohol. **5**

Q.3 i. Write a short note on NDPS Act, 1985. **2**
ii. Explain the classification of drugs with examples. **8**
OR iii. Drug poisoning is one the most important causes of death. Elaborate in detail the several factors influencing the poisoning. **8**

Q.4 i. Describe the three elements of fire. **3**
ii. Few debris were found at the Arson crime scene, explain how these exhibits will be analysed in the gas chromatography with the help of appropriate diagram. **7**

OR iii. Elaborate in detail the three stages of combustion. **7**

Q.5 i. Write the composition of petroleum products. Also mention different hydrocarbons which are present. **4**
ii. Explain the procedure of fractional distillation. **6**
OR iii. Write about any six petroleum products obtained after the refining process. **6**

Q.6 Attempt any two:
i. Distinguish between primary high explosives and secondary high explosives. **5**
ii. Write any five characteristic nature of an explosive. **5**
iii. What are IEDs and Home-made explosives? **5**

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Marking Scheme

FS3CO09 Forensic Chemistry

Q.1 i) (b) stomach and small intestine **1**

ii) (b)Alcohol dehydrogenase **1**

iii) d) The Cocaine drug Act, 1875 **1**

iv) c) both a and b **1**

v) c) Charcoal **1**

vi) b) Pour Pattern **1**

vii) a) Unused metal Cans **1**

viii) a) Higher **1**

ix) a) Detonation **1**

x) a) Ammonium nitrate fuel oil **1**

Q.2 i. The informal and illicit production of alcoholic drinks is practiced in various parts of the world, including in countries where alcohol is banned. a number of small production units operate clandestinely. The raw materials used are similar to those in the country made liquor, but since they evade legal quality controls the alcohol concentration in their products varies and adulteration is frequent. 2 Marks

ii. As soon as ethanol enters the blood, the body starts to dispose it of by metabolism and excretion. About 90% of alcohol absorbed is oxidised in the liver, and the remaining 10% is excreted. In the liver, alcohol is oxidised to acetaldehyde by alcohol dehydrogenase (ADH) and its coenzyme, nicotinamide adenine-dinucleotide (NAD). The second step, acetaldehyde is transformed into free acetic acid or its activated form, acetyl coenzyme A. Finally, the acetate enters the general pool, and undergoes oxidation to C02 and water in the citric acid (Krebs) cycle. Acetate can form glycogen, proteins and possibly fats and cholesterol. 3 Marks

iii. **Analysis for Methyl Alcohol**

Chromotropic Acid Test

I. About 1 ml or appropriate amount of sample (distilled or as such depending upon the nature of sample and concentration of methanol) is taken in a test tube and about 2 ml of Potassium Permanganate solution (3 gm potassium permanganate and 15 ml of Phosphoric/Ortho Phosphoric Acid in 100 ml distilled water) is taken and shaken well.

II. Now few crystals of Sodium Bisulphate are added with shaking till disappearance of colour (Potassium Permanganate colour) of the solution.

III. About 1 ml of Chromotropic Acid (5% of aqueous solution of sodium salt of Chromotropic Acid) and concentrate Sulphuric Acid is added slowly with inner sidewall of the test tube to the extent of 15 ml.

IV. Appearance of violet colour indicates the presence of Methanol.

Schiff's Reagent Test

I. About 4.5 ml of sample (distilled or as such depending upon the nature of sample) is taken in a test tube and 0.5 ml of ethanol (if the concentration of ethanol is high in the sample, the sample is fortified accordingly is added so that 5 ml volume should contain only 0.5 ml ethanol.

II. 2 ml of 3% Potassium Permanganate solution and .2ml of Phosphoric Acid is added.

III. The whole content is left for 10 minutes. 1 ml of 10% Oxalic Acid is added followed by 1ml of concentrated Sulphuric Acid.

IV. The contents are cooled at room temperature. 5 ml of Schiff's reagent is now added and kept for half an hour to observe the colour.

V. Appearance of purple colour indicates positive test for the presence of methanol.

Test for Furfural

About 5 ml or appropriate amount of sample (distilled or as such depending upon the nature of sample and concentration of furfural) is taken in a test tube and about 1 ml Aniline and about 0.5 ml Hydrochloric Acid is added to it and kept for 15 minutes. Appearance of red colour indicates the presence of Furfural.

Alternative method

About 2 ml or appropriate amount of the sample (distilled or as such depending upon the nature of sample) is taken in a test tube and about 0.2 ml of Aniline and about 0.4 ml of Glacial Acetic Acid is added to it.

If the furfural is present in the sample, red colour develops in a few seconds & reaches its maximum intensity in 5-10 minutes.

5 Marks

OR iv. When jerking movement is in the direction of the gaze and independent of the position of the head. it is known as alcohol gaze nystagmus and appears at blood levels of 40 to 100 mg.% (average 80 mg.%) . It is not a constant or common sign. Mental concentration is poor and judgement impaired.

Blood alcohol concentration Effects

0 to 50 mg % -No significant effect or mild euphoria.

50 to 100 mg% -Decreased inhibitions, increased self-confidence, decreased attention span, slurring of speech, mild incoordination, alteration of judgement, nystagmus.

100 to 150 mg % -Some mental confusion, emotional instability, loss of critical judgement, ataxia, impaired memory, sleepiness, slowed reaction time.

150to 300 mg%- Loss of muscular coordination, staggering gait, marked mental confusion, drowsiness, exaggeration of emotions, dizziness, decreased pain response, disorientation; thickened speech.

300 to 400 mg% -Stupor, marked incoordination, marked decrease in responses to stimuli, possibly coma.

400 mg % & above- Anaesthesia, depression of responses, respiratory failure, deep coma, death 5 Marks

Q.3 i. NDPS act was amended in 1989 and 2001. It repeals three acts: (1) The Opium Act, 1857. (2) The Opium Act, 1878. (3) The Dangerous Drugs Act, 1930. The Act consolidates and amends the existing laws relating to narcotic drugs, strengthens the existing laws relating to narcotic drugs, strengthens the existing controls over drugs of abuse, enhances the penalties particularly for illegal trading offences, makes provision for exercising effective control over psychotropic substances, and makes provision for the implementation of international conventions relating to narcotic drugs and psychotropic substances. A psychotropic drug is one that alters mental function b. its action. A narcotic drug means Cocoa leaf, Cannabis. Opium, Poppy straw and includes aU manufactured drugs. "Psychotropic substance", means any substance, natural or synthetic, or any natural material or an. or preparation of such substance or material. in the list of psychotropic substances **8**

ii. **Narcotics** **8**

The term "Narcotic" is derived from the Greek word "Narkotikos", which implies as state of lethargy or sluggishness. Narcotic drugs are those substances which gives relief from pain and induce sleep but generally not acceptable. They act on the Central Nervous

System and produce an altered state of mind of the subject. Drugs which interact with those receptors in the brain are responsible for the transmission and response to pain.

Depressants

which are often referred as central-depressants are psychoactive drugs that temporarily reduce neuro-transmission levels resulting in retardation in arousal or stimulation in either mental or physical functions or both. The effects that depressants generally exert may include pain relief, sedation, cognitive/memory impairment, as well as in some instances euphoria, muscle relaxation, lowered blood pressure, dissociation, respiratory depression, anticonvulsant effects, and even complete anaesthesia or death at high doses.

Stimulants

Stimulants which are often referred as psycho-stimulants are psychoactive drugs that temporarily induce improvements in either mental or physical functions or both. The effects that stimulants generally exert may include enhanced alertness, wakefulness and locomotion. Due to their rendering a characteristic "up" feeling, stimulants are also occasionally referred to as "uppers". Stimulants have a marked contrast to that of Depressants or "downers", which decrease mental or physical function or both.

Hallucinogens

Hallucinogens, also known as Psychedelics or Psychotomimetic Agents, are substances that induce changes in thought, perception, and mood, without causing major disturbances in the Autonomic Nervous System. Perceptual alterations can take the form of illusions, synaesthesia, or hallucinations. An illusion is the result of misinterpretation of an actual experience, while synaesthesia are sensory misperceptions, e.g. hearing colour or seeing sounds. Both require external stimuli for their institution.

OR iii. **On- Target Effects** **8**

An important concept in drug toxicity is that an adverse effect may be an exaggeration of the desired pharmacologic action due to alterations in exposure to the drug. This can occur by deliberate or accidental dosing error, by alterations in the pharmacokinetics of the drug, e.g., due to liver or kidney disease or to interactions with other drugs, or by changes in the pharmacodynamics of the drug-receptor interaction that alter the pharmacologic response, e.g., changes in receptor number. All such changes can lead to an increase in the effective concentration of the drug and thus to an increased biological response

Off- Target Effects

Off-target adverse effects occur when the drug interacts with unintended targets. Indeed, few drugs are so selective that they interact with only one molecular target. Enantiomers (mirror image isomers) of a drug can also cause off-target effects.

Production of Toxic Metabolites

Virtually all drug molecules are metabolized by the liver and/or other tissues. Sometimes metabolism produces a pharmacologically active metabolite. A drug metabolite can have an adverse effect. A clinically significant example is that of acetaminophen, a commonly used analgesic and antipyretic.

Idiosyncratic Reaction

Idiosyncratic drug reactions are rare adverse effects for which no obvious mechanism is apparent. These idiosyncratic reactions are often thought to reflect unique individual genetic differences in the response to the drug molecule, possibly through variations in drug metabolism or immune response.

Pharmacokinetic Drug-Drug Interactions

Pharmacokinetic interactions between drugs arise if one drug changes the absorption, distribution, metabolism, or excretion of another drug, thereby altering the concentration of active drug in

the body. Drugs can inhibit or induce hepatic P450 enzymes. If two drugs are metabolized by the same P450 enzyme, the competitive or irreversible inhibition of that P450 enzyme by one drug can lead to an increase in the plasma concentration of the second drug.

Pharmacodynamic Drug-Drug Interactions

Pharmacodynamic interactions arise when one drug changes the response of target or non - target tissues to another drug. Toxic pharmacodynamic interactions can occur when two drugs activate complementary pathways, leading to an exaggerated biological effect. Co exposure to the two drugs increases cGMP to an even greater degree, increasing the risk of severe hypotension.

Q.4 i. **Fuel:** This is anything that will burn. Fuel must be available for ignition. It may be in the form of a solid, a flammable liquid or gaseous state. Solids may be wood, cloth or paper. Examples of flammable liquids are kerosene, oil and gasoline. Vapours from paint, gasoline and other flammable materials are considered gaseous. Understanding that there are invisible, potentially dangerous vapours surrounding flammable chemicals is very important. Natural gas and propane are other examples of flammable materials in a gaseous state. **3**

Oxygen: This is needed for combustion. Fires use oxygen to maintain a state of combustion (burning). Fires also produce smoke and poisonous gases.

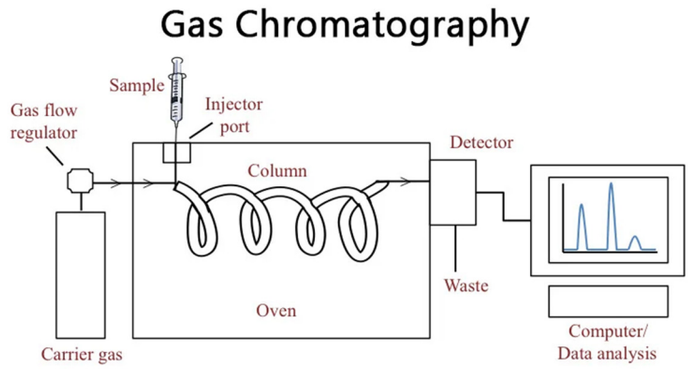
Heat: Combustible materials may catch fire at ignition temperatures. Heat is needed to start a fire. For many items found in the home, the combustion temperature is 400 - 600 degrees Fahrenheit. Some items may ignite more easily than others.

ii. **Gas chromatography** **7**

This chromatographic method is used to detect the discriminating affinity of components to the adsorbent materials. Making use of GS syringe the sample is introduced in the liquid/gas form into the injection port. At the injection port vaporization of sample takes place and passed through column with the help of mobile phase which is continuously in motion. Mobile phase is mainly H2 that gets separated/detected at the detection port with suitable temperature programming. We visualize this on computer in the form of peaks. It is a powerful method used for separation, identification and quantization of components in a mixture. In this method, sample collected is first converted into its vapor form and then a carrier gas is used to flow the vapors into a thermally-controlled column.

Experimental Condition
Suitable volume of the concentrated extracts of the exhibit, standards and blank samples are injected into a gas chromatograph with the following conditions: - Column: Pack SE – 30, Apiezon L or its equivalent column, which can be used for the separation of petroleum products etc. 1. Detector: Flame Ionization Detector (FID)

Carrier Gas: Nitrogen or Helium
3. Flow Rate: 30 mL/min
4. Oven Temperature Programme:
5. Detector Temperature: petrol-270 kerosene- 230 diesel-240
6. Injector Temperature: petrol-270 kerosene- 230 diesel-240



OR iii. **Three Phases of Combustion** The burning process occurs in clearly defined stages. For a fire fighter it is important to recognize different phases of fire so that he can understand the different levels of burning fires and to fight against it using different tools. These phases are classified on the basis of atmospheric conditions. **7**

Incipient/Initial Phase (Growth Stage): This is the first phase; here fire produces water vapor, carbon dioxide, perhaps a small quantity of sulfur dioxide, carbon monoxide and other gases. Also in this phase the air oxygen content is reduced and produces fire. The fire may be producing a flame temperature well above 1,0000 F (5370C), yet the temperature in the room at this stage may be only slightly increased.

Free-Burning Phase (Fully Developed Stage): The second phase involves the all burning activities of the fire. In this phase, air rich in oxygen is strained into the flame and convection carries heat to the upper most regions. The gases heated up spreads out from the top downward, resulting in increased concentration of cooler air at low levels and results in the ignition of combustible material. Due to this heated air, firefighters are taught to keep low and use protective breathing equipment. One breath of this super-heated air can sear the lungs. At this point, the temperature in the upper regions can exceed 1,3000 F (7000C). In the later stages of fire, it starts to progress and oxygen is continuously consumed by it and the point where there is insufficient oxygen to react with the fuel. The fire is then reduced to the smouldering phase and needs only a supply of oxygen to burn rapidly or explode.

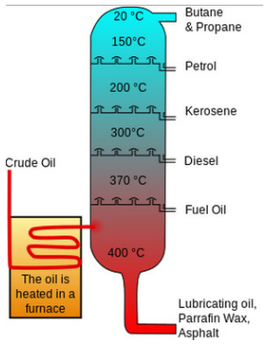
Smouldering Phase (Decay Stage): In this phase flame may cease to exist if the area of confinement is sufficiently airtight. In this burning is reduced to glowing embers. Room becomes completely filled with dense smoke and gases it forced from all cracks under pressure. Fire will continue to smolder and room will be filled with gases after combustion over 1000 degree F

Q.5 i. . It is a mixture of many substances that help in manufacturing of various products i.e. Kerosene, gasoline, fuel oil, lubricant oil etc. The petroleum products are made up of two main elements i.e. carbon and hydrogen hence comes under the category of hydrocarbons. Other elements (Oxygen, Nitrogen and Sulphur) may present in lesser amounts with trace amounts of phosphorus and heavy metals such as Nickel and Vanadium.
Paraffins, Naphthenes, aromatics and asphaltics aredifferent hydrocarbons present.

ii. Procedure of fractional distillation is as follow: **6**

- Initially, the crude oil is heated to a temperature of 1112°F / 600°C. The mixture heats up and form gases or vapours.
- The formed vapours then moves down to the bottom of the column.
- The trays at bottom have holes that allow the movement of vapour.
- The top most segment of the column is cold and bottom is hot, therefore vapour rises in the column and gets cooled.
- A substance in the vapour when reaches a height with temperature equal to the boiling point of the substance, it get condensed and liquid is formed. This is then collected by trays.

The two fractions are: light fractions having gasoline, kerosene, and fuel oils and heavy fractions containing lubricating oils and heavy gas oil. Asphalt cement, waxes, and feedstock are residual compounds from the distillation tower.



OR iii. Products from Crude Oil Further refining of these products is done generate materials more common to everyday life. The ten main products of petroleum/crude oil are given as below) **(Any six)** **6**

Asphalt: Asphalt is commonly used to make roads. It is colloid solution of asphaltenes and maltenes and separated from other components by fractional distillation. Once collected, is processed in a de-asphalting unit. In which it reacts with oxygen and become harder. It is usually stored and transported at around 300° Fahrenheit.

b) Diesel: It is that fraction of petroleum which can be used as a fuel in a diesel engine. Diesel is produced by fractional distillation between 392° to 662° Fahrenheit. The density of diesel is more than gasoline and it is easy to refine it from crude oil. One of its major use is in transportation.

c) Fuel Oil: Any liquid petroleum that burned to generate heat comes under the category of Fuel oil. It is also a heaviest commercial fuel produced. It is classified as diesel, light, gasoil, heavy and residual fuel oil. Among them heavy and residual fuel oils are also called bunker or navy special fuel oil.

d) Gasoline: Half of the crude oil is converted into gasoline. It is mainly used in car engines or internal combustion engines. It is made up of naphthenes, paraffins and olefins. The specific ratios will depend on the refinery processes. Gasoline is enhanced with iso-octane and ethanol in order to use in cars. Gasoline can be petrol, petroleum spirit, gas, petro-gasoline, and mogas.

e) Kerosene: It is collected through fractional distillation between 302° and 527° F of temperature. It is clear and thin combustible liquid used as heating fuel (jet fuel).

Liquefied Petroleum Gas: This is mixture of gases used in heating appliances, aerosol propellants, and refrigerants. Different kinds of liquefied petroleum gas, or LPG, are propane and butane. The composition of LPG evaporates at normal atmospheric pressure and hence this is kept in pressurized containers like cylinders as liquid under pressure hence known as LPG (liquefied petroleum gas).

g) Lubricating Oil: It consists of base oils and additives. Mineral oils are made by unique processes known as catalytic dewaxing, solvent extraction, isohydromerization and hydrocracking. They are used in between the surfaces to reduce friction. Motor oil is commonly known lubricating oil used for protection of moving parts of internal combustion engine.

h) Paraffin Wax: It is a white, waxy solid at room temperature. It is odourless and tasteless. Depending on several factors the melting point of the paraffin wax is around 117° to 147° Fahrenheit. It is used as electrical insulator and used in drywalls to insulate buildings.

i) Bitumen: It is a thick, black sticky material. During refining process it is formed at bottom of the column because its boiling point is very high (977° Fahrenheit) and it does not rise in the distillation chamber. This is used in waterproofing roofs, boots, paving roads, hard drives in computers and dishwashers.

j) Petrochemicals: These are chemical products such as ethylene, propylene, benzene, toluene and xylene made by raw materials of petroleum.

Q.6

i. **Primary High Explosives** **5**

The explosives which are extremely sensitive to mechanical shock, friction, and heat, to which they will respond by burning rapidly or detonating are known as Primary High Explosives.Lead Azide, Lead Styphnate, DDNP and Tetrazene are some of the examples of Primary High Explosives.

Secondary High Explosives

Secondary high explosives are also known as base explosives. They are comparativelyunresponsive to shock, resistance, and heat. They may ignite when exposed to heat or flame in trivial, liberated quantities. These are sometimes added in small amounts to blasting caps to boost their power.The secondary high explosives may further divide into Boosters and Main Charge.

Example Booster-RDX Main Charge-Dynamite

ii. **Availability and Cost:-**Depending on the availability of raw materials, its cost, complexity and its safety for manufacturing operations the formation of an explosive depends. **5**

Sensitivity:-Sensitivity is the ease with which an explosive can be detonate or ignited. An explosive is sensitive to shock, friction or heat. Sensitivity should be considered in selecting an explosive suitable to its particular use.

Sensitivity to initiation:-Sensitivity to initiation is defined by the power of the detonator which is certain to prime the explosive to a sustained and continuous detonation.

Velocity of detonation:-It is that speed with which the reaction process spreads in the mass of the explosive, which is a significant feature of explosive and differs according to the kind of explosive.

Stability:- One of the main characteristic of explosive is its ability to be stored without detonation which is known as stability. The stability is affected by temperature of its storage, chemical constitution of explosive, exposure to sunlight and its electrical discharge.

Power, functioning, and potency:-The power or functioning of an explosive is its ability to do work which is determined by some tests to measure the substance for its proposed use.

iii. Home made explosive **5**

A **Molotov cocktail** consists of a glass bottle semi-filled with flammable liquid, usually gasoline (petrol) or alcohol (generally methanol or ethanol), the mouth of the bottle is fitted with a cork or other type of airtight bung (rubber, glass, or plastic), and a cloth rag fixed securely around the mouth. The weapon is used by first soaking the rag in a flammable liquid immediately prior to using it, lighting the rag and throwing the bottle at the target. The bottle shatters on impact, spilling the flammable liquid over the target, which is then ignited by the burning rag.

An I**mprovised Explosive** Device is a device, assembled in contravention to the existing rules of Law of Nation adopting unconventional or semi-conventional methods of assembling a standard device, ammunition/explosives or commercial, with a criminal/anti-national intention.IED is also known as homemade bomb.For ExampleRoadside bombs, Letter Bomb, Bombs incorporated in Briefcase/vehicle etc

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