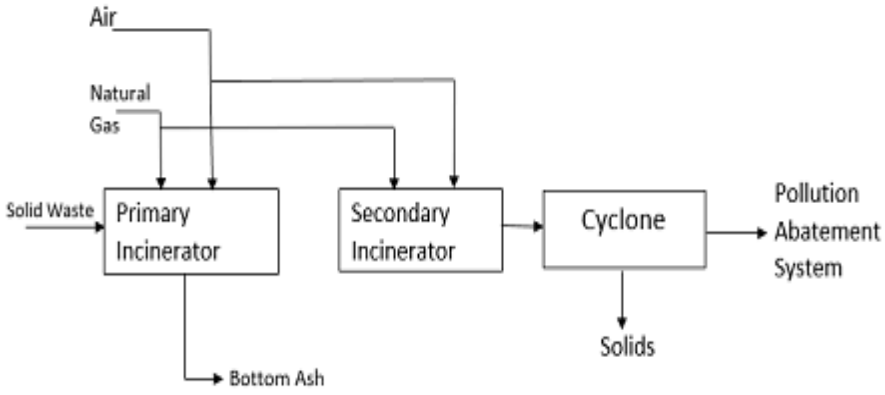
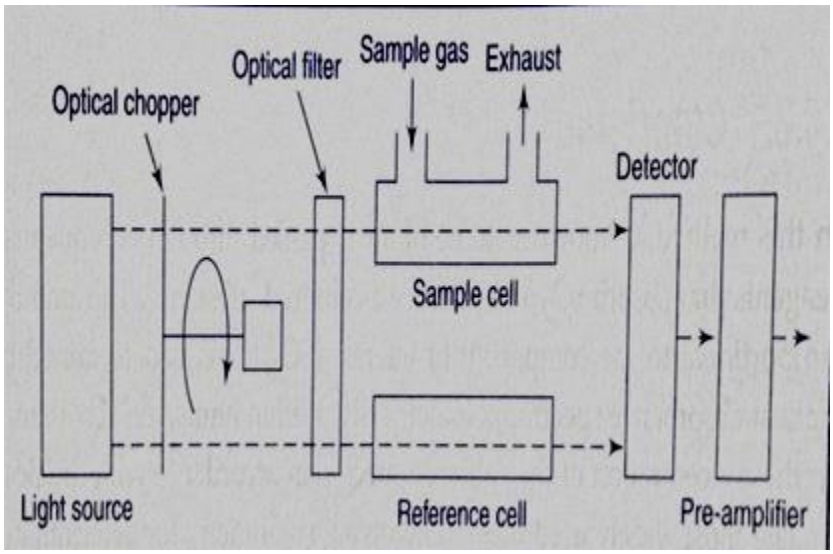
SUMMER – 2022 EXAMINATION

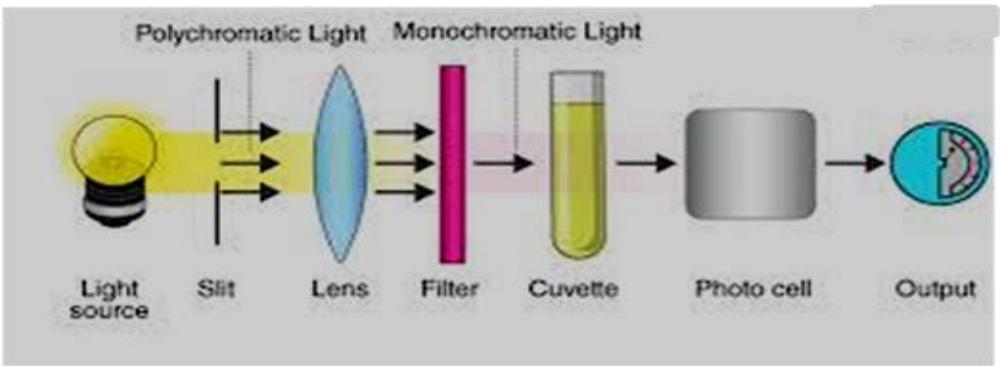
Subject Name: Analytical Equipment **Model Answer** **Subject Code: 22435**

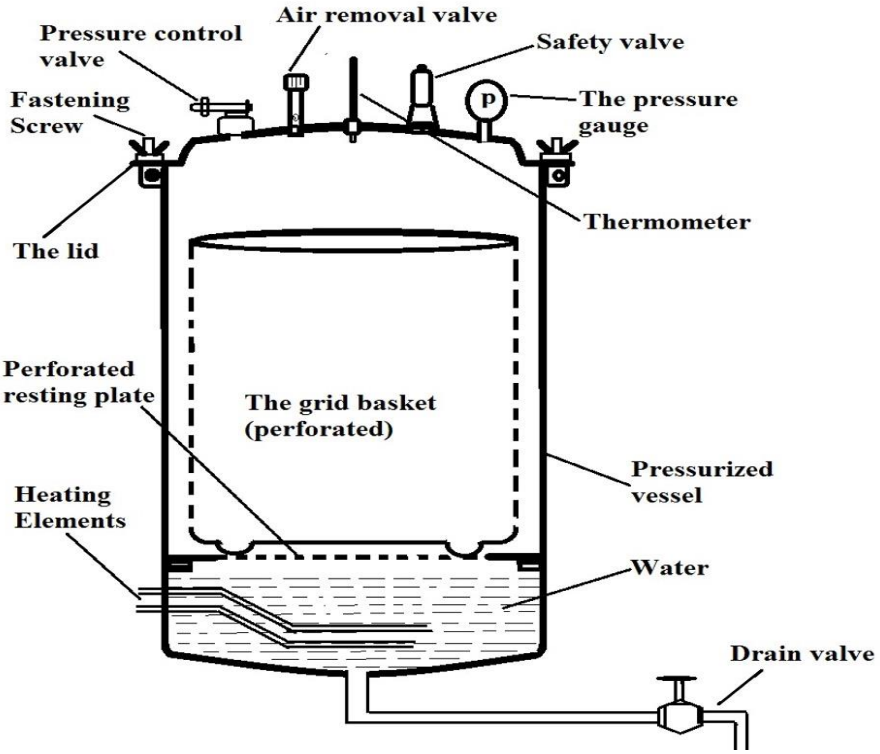
Important Instructions to examiners:

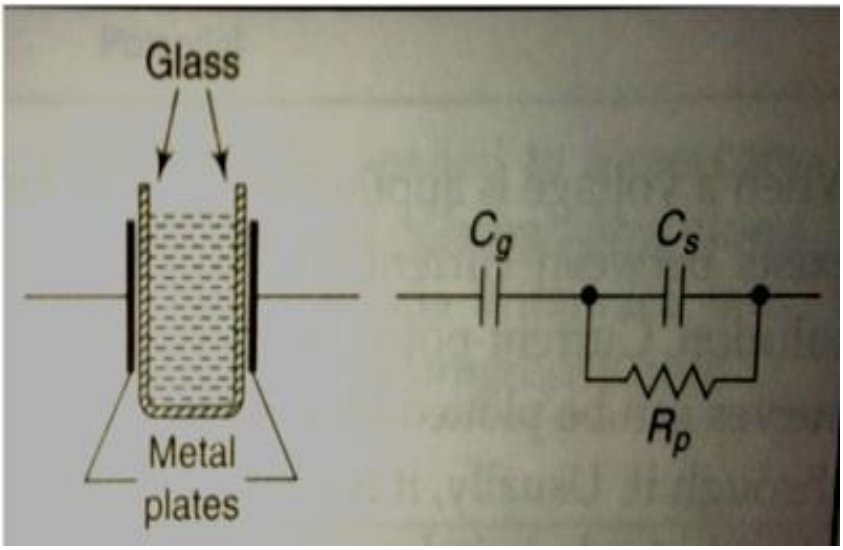
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

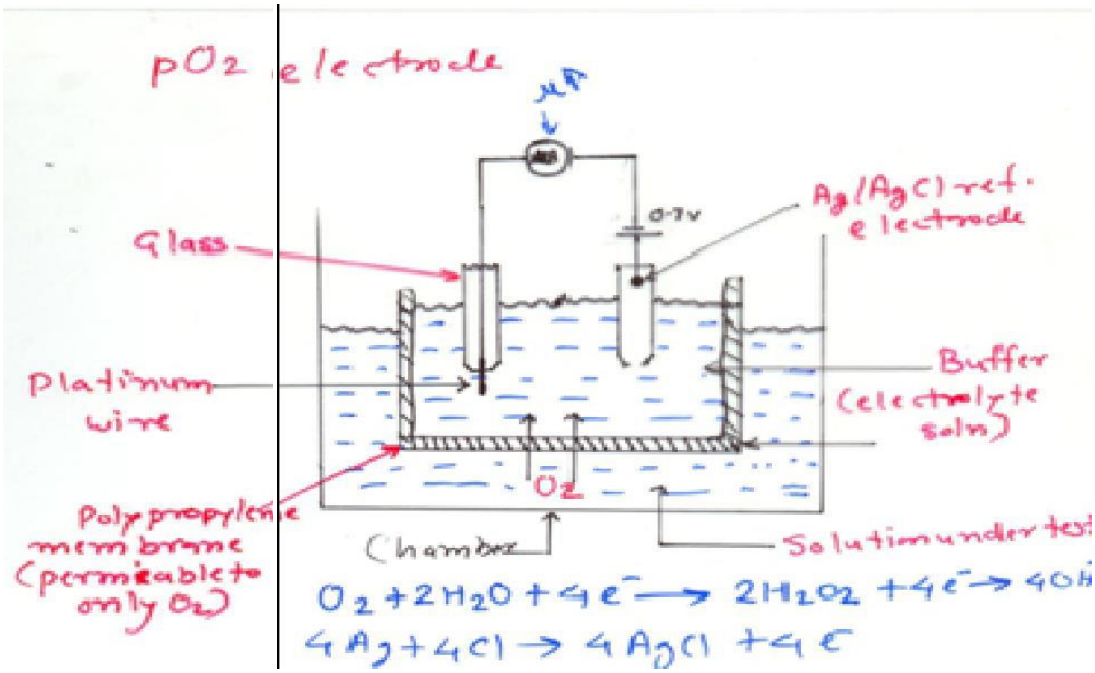
Q. No.	Sub Q. N.	Answer	Marking Scheme
1.		**Attempt any FIVE of the following:**	10 M
	a	**List application of the colorimeter (any 02)** **Ans:** 1. It is widely used in hospital & laboratory for estimation of biochemical samples, like plasma, serum, cerebrospinal fluid (CSF), urine. 2. It is also used to quantitative estimation of serum components as well as glucose, proteins and other various biochemical compounds. 3. They are also used to determine the concentrations of hemoglobin in the blood and to identify substandard and counterfeit drugs.	02 M
	b	**Draw neat diagram of Incinerator (Medical).** **Ans:**  **Fig: Incinerator**	02 M

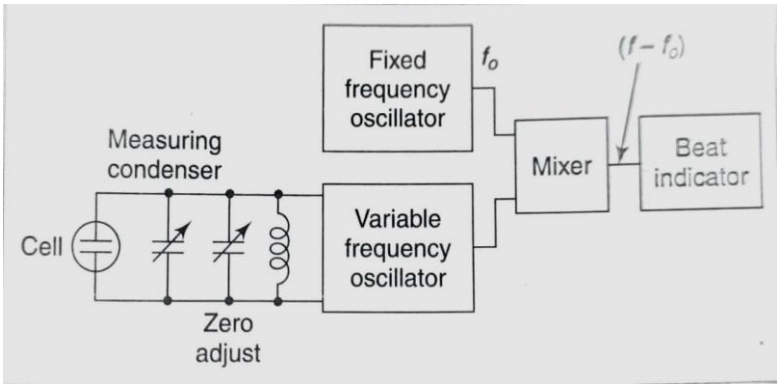
	c	**List two methods to count blood cell.** **Ans:** 1. Electro-conductive blood cell counter 2. Dark field blood cell counter	**02 M**
	d	**Suggest the meter to measure hydrogen ion concentration in the given solution.** **Ans:** A pH meter is used to measure hydrogen ion concentration.	**02 M**
	e	**Draw a neat labeled diagram of non dispersive infrared analyzer for carbon monoxide measurements.** **Ans:**  **Fig: Non dispersive infrared analyzer for carbon monoxide measurements.**	**02 M**
	f	**Suggest sterilizing equipment for sterilizing Biomedical waste.** **Ans:** Sterilizing equipment used is Autoclave.	**02 M**
	g	**Give the significance of temperature compensation in conductivity measurement.** **Ans:** An increase in a solution's temperature will cause a decrease in its viscosity and an increase in the mobility of the ions in solution. An increase in temperature may also cause an increase in the number of ions in solution due to dissociation of molecules. As the conductivity of a solution is dependent on these factors then an increase in the solution's temperature will lead to an increase in its conductivity. Thus temperature has a significant effect on the measured conductivity. Having both the temperature and ion movement changing would make it near impossible to take useful conductivity measurements. If the temperature was held constant, the conductivity measurement would only have the variable of ion concentration. That is why temperature compensation with a temperature probe is important.	**02 M**

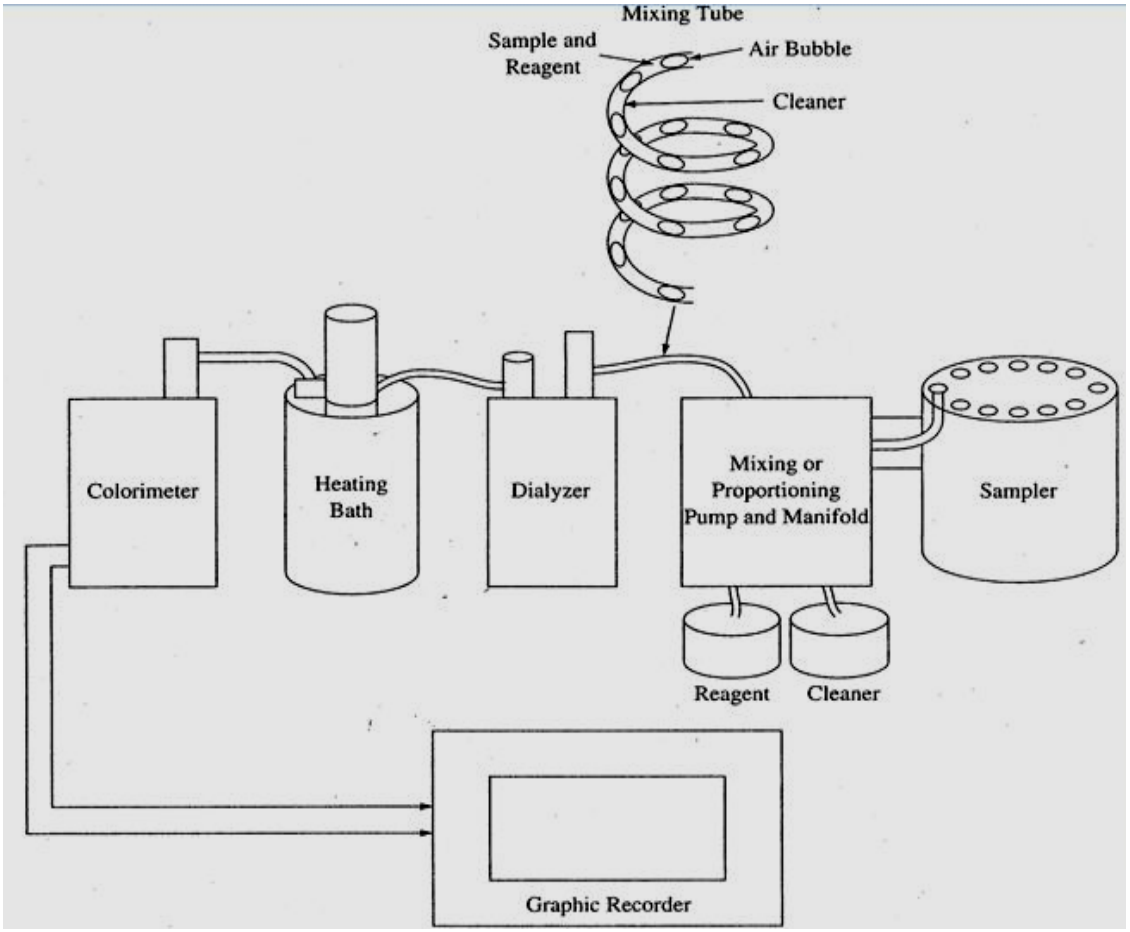
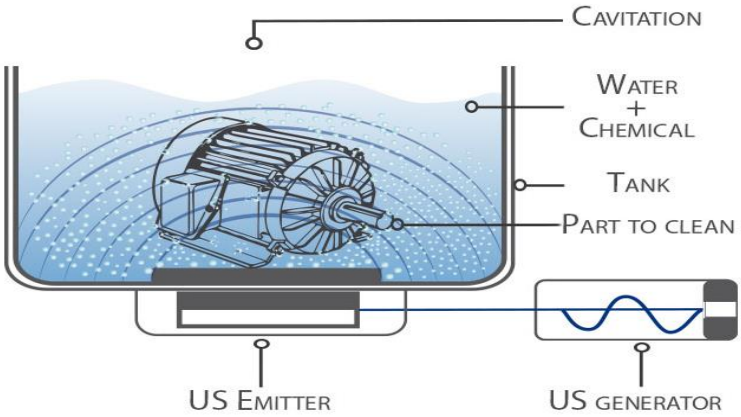
2.		Attempt any THREE of the following:	12 M
	a	**Draw neat sketch of colorimeter and state its four technical specifications.** **Ans:**  **Fig: Colorimeter** **Any four technical specifications** 1. Readout : Graphical 4 line, 16 character per line LCD 2. Wavelengths : 430nm, 520 nm, 570 nm, 620 nm 3. Wavelength Accuracy: ± 2 nm 4. Readable Resolution: Determined by reagent system 5. Wavelength Bandwidth : 10 nm typical 6. Photometric Range : -2 to +2A 7. Photometric Precision : ± 0.001A 8. Sample Chamber : Accepts 25 mm diameter flat-bottomed test tubes, 10 mm square cuvette, 16 mm COD test tubes 9. Light Sources : 4 LEDs 10. Detectors : 4 silicon photodiodes with integrated interference filters 11. Modes : Absorbance, pre-programmed tests 12. Pre-Programmed Tests: YES, with automatic wavelength selection 13. User Defined Tests : Up to 10 user tests can be input 14. RS232 Port : 8 pin m DIN, 9600b, 8, 1, n 15. Power Requirements : Battery Operation: 9 volt alkaline Line Operation: 120/220V, 50/60 Hz with adapter 16. Dimensions : (L x W x H) 8.5 x 16.2 x 16.7 cm, 3.4 x 6.4 x 2.6 inches Weight 312 g, 11 oz (meter only) 17. Data Logger : 350 test results stored for download to a PC	**02 M** **02 M**

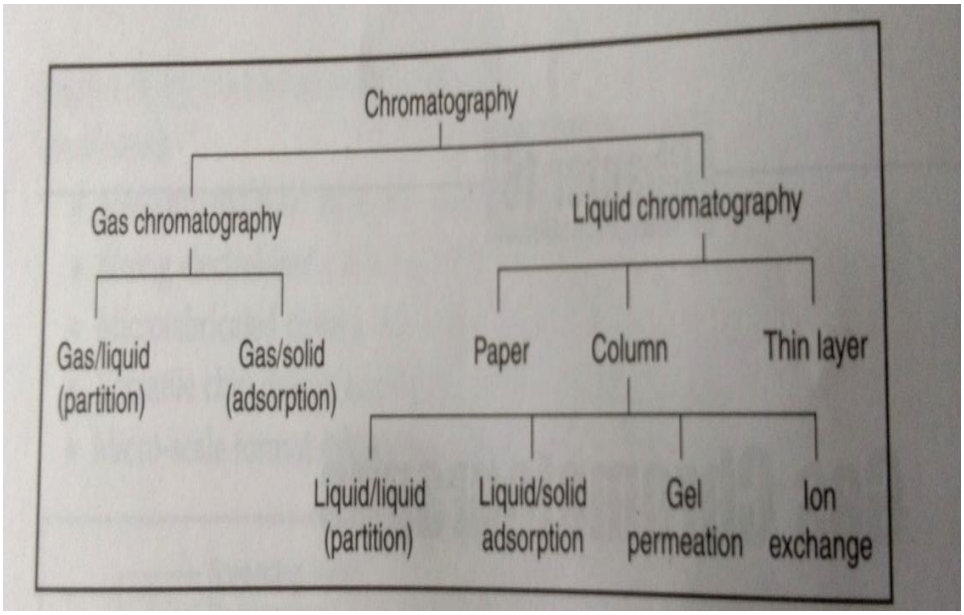
	b	**With neat diagram explain working of autoclave.** **Ans :**  **Fig: Autoclave** Also known as a steam sterilizer, an autoclave is an insulated pressure chamber in which high-pressure steam is used to sterilize (decontaminate) laboratory/clinical material or items. One of the biggest advantages of using steam is that unlike boiling water, steam creates high pressure with increasing temperature. Water is added to a certain level so that the material in the basket sits just above the water level. Once the water is added, the lid is tightly closed. As the water is heated, it turns to steam (the gaseous form of water) which occupies more space as compared to water. As the temperature increases, pressure builds up in the inner chamber. The increasing temperature causes the molecules to vibrate faster. This not only causes the gaseous molecules to take up more space but results in increased pressure. In the inner chamber, very high pressure is exerted on the microorganisms on the surface of material/substances being sterilized. This is why it's important to ensure that the materials are not overcrowded in the inner chamber. Overcrowding prevents steam from penetrating certain areas. Apart from the high pressure created in the chamber, the heat within the chamber also kills the microorganisms present. When the hot steam comes into contact with the surfaces of the material being sterilized, the steam condenses into a small volume of water. Given that these surfaces are cooler than the steam, latent heat from steam molecules is released to the cooler surface as they condense to water. As a result, the condensed water molecules become cooler which in turn results in suction of more hot steam to the site. This continues until the site becomes as hot as the steam. In the process, microorganisms located on the surface of the materials/substances are destroyed. In order to ensure that all the microorganisms present on the material being sterilized are killed, it's important to sterilize them for a given period of time. Generally, this takes about 15 minutes.	**02 M** **02 M**

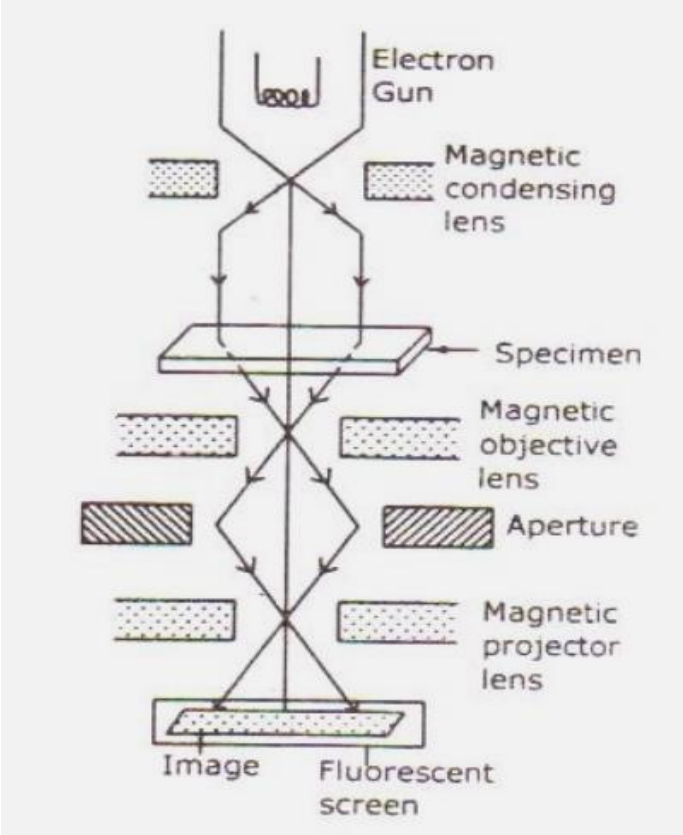
	c	**Draw and explain equivalent circuit diagram of conductivity cell.** **Ans:**  **Fig: Equivalent circuit diagram of conductivity cell** A typical sample cell for high frequency conductivity measurement may be composed of two metallic plates sealed on to the wall of a rectangular container. When the solution is put in the container, the metal plates act as a condenser with solution and glass as the dielectric. The equivalent circuit of the conductivity cell is shown in fig. C_g represents the capacitance of the glass walls of the cell, C_s is the capacitance of the sample and R_p is the resistance in parallel with C_s. The resistive component is very high and offers negligible contribution. Capacitive effect is the major factor in high frequency measurements, whereas resistive balance is more important in low frequency measurements.	**02 M** **02 M**
	d	**Following are the full scale measurement range for various gas pollutant suggest measurement tech for following pollutants,** **i) Carbon monoxide – 0 to 50 ppm** **ii) Hydrocarbons-0 to 80 ppm** **iii) Sulphur Oxide – 0-2 ppm** **Ans: Measurement tech for given pollutants:** i) **Carbon monoxide – 0 to 50 ppm:** Infrared absorption. ii) **Hydrocarbons-0 to 80 ppm:** Ultraviolet absorption, Gas chromatography Mass spectrometry. iii) **Sulphur Oxide – 0-2 ppm:** Ultraviolet absorption ,Infrared absorption , Gas chromatography, colorimetric method , Conductimetric method, coulometric method.	 **01 M** **01 M** **02 M**
3.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a	**In laboratory, doctor wants to separate red blood cell, WBC. Suggest them the device. Also classify this device briefly.** **Ans:** Suggested device to separate red blood cell, WBC is Centrifuge.	 **01 M**

		Classification of Centrifuge: 1) Hand Centrifuge. 2) High-speed Centrifuge. 3) Low speed Centrifuge. 4) Refrigerated Centrifuge. 5) Ultracentrifuge.	**03 M**
	b	**With neat diagram give working of PO2 electrode.** **Ans:**  **Fig: PO2 electrode** The PO_2 electrode is known as Clark electrode after its inventor and it is an O2 sensor for blood. The electrode arrangement consists of two chambers and they are separated by polypropylene membrane i.e. permeable to O_2. The blood sample is injected into lower sample chamber as shown in the figure The upper chamber contains the electrode. The O_2 in the blood permits the polypropylene membrane and reacts chemically with a phosphate buffer contained in the upper chamber. The buffer maintains the solution pH at a constant level. The O_2 combines with water in the buffer producing electrons proportion to the number of O_2 molecules according to the formula: $O_2 + 2H_2O + 4e^- \rightarrow 4[OH]^+$ The electron current is measured by the ammeter. It is directly proportional to PO_2. Electrons on the left side of the equation are produced by a source voltage that polarizes the electrode and has value 0.7V, This voltage is called polorographic voltage. The electrode is called Clark's polorographic electrode The meter scale is calibrated in units of PO2 in the blood. This electrode current depends on current blood in the solution rather than membrane potential as it was in pH measurement.	**02 M** **02 M**

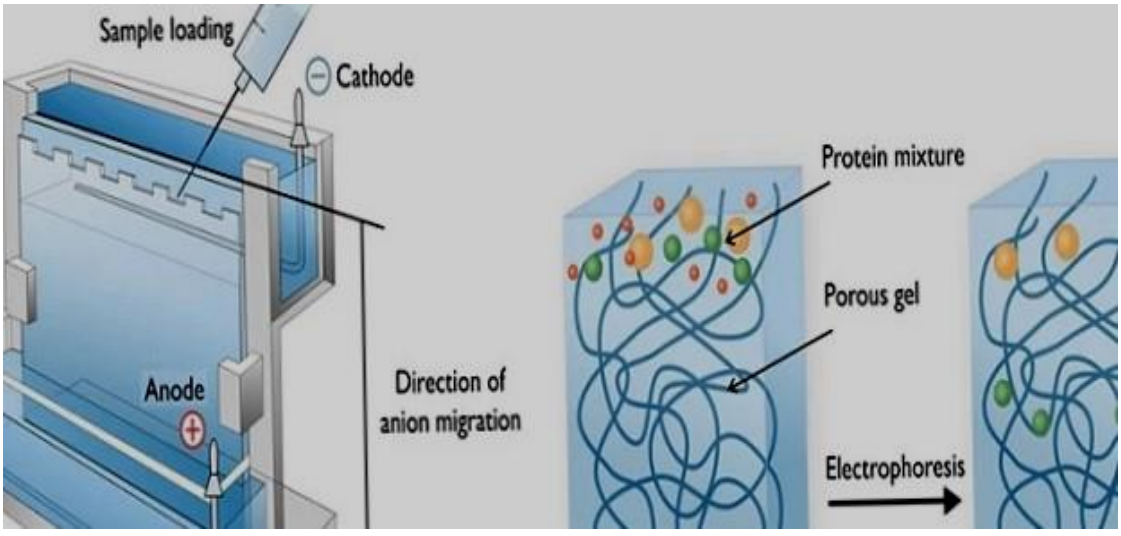
	c	**Draw labeled diagram for beat frequency method for measuring conductivity and give its working.** **Ans:**  **Fig: Beat frequency method for measuring conductivity** The sample cell is usually placed in parallel with calibrated capacitor. In order to achieve the resonant frequency, the exact amount of capacitance which is added by the sample is removed by adjustment. This gives the measure of conductivity. The beat frequency method can also be used to measure output frequency of two oscillator circuits. The above figure shows the sample cell as part of oscillator capacitance and the other is of fixed frequency .The output of the two when given to mixer unit would be the difference of the two frequencies (f-f0) which would be directly proportional to the changes in high frequency capacitance of the cell, The difference in frequency is measured directly with the beat indicator.	**02 M** **02 M**
	d	**List different pollutants present in the atmosphere.** **Ans: (Any Four)** 1. Carbon monoxide 2. Hydrocarbons 3. Sulphur oxides 4. Nitrogen oxides 5. Oxidant	**04 M**

4.		**Attempt any <u>THREE</u> of the following:**	**12 M**
	a	**Draw and label block diagram of auto analyzer.** **Ans:**  **Fig: Auto analyzer**	**04 M**
	b	**i) Draw a neat diagram of Ultrasonic cleaner machine.** **ii) Give applications of the same (any four).** **Ans:**  **Fig: Ultrasonic cleaner machine**	**02 M**

		Applications of Ultrasonic cleaner machine: (Any Four) 1) Surgical instruments 2) Dental instruments 3) Implants 4) Delicate medical tools and devices. 5) Useful for removing blood stains, portions of skin and biological waste from delicate instruments.	**02 M**
	c	**Define chromatography. Give brief classification of chromatography.** **Ans:** Separation of components from complex mixture by a continuous distribution of the component between two phases**.** **OR** Chromatography is a very useful technique as it allows the separation of components of a mixture on the basis of their nature, structure, size, and other properties.  **Fig: Classification of chromatography**	**02 M** **02 M**

	d	**Draw labeled diagram of Transmission Electron Microscope. List function of any four components of it.** **Ans:** **In Transmission Electron Microscope** electrons are made to pass through the specimen and the image is formed on the fluorescent screen, either by using the transmitted beam or by using the diffracted beam.  **Fig: Transmission Electron Microscope** **Function of components (any four)** 1. It consists of an electron gun to produce electrons. 2. Magnetic condensing lens is used to condense the electrons and is also used to adjust the size of the electron that falls on to the specimen. The specimen is placed in between the condensing lens and the objective lens as shown. 3. The magnetic objective lens is used to block the high angle diffracted beam and the aperture is used to eliminate the diffracted beam (if any) and in turn increases the contrast of the image. 4. The magnetic projector lens is placed above the fluorescent screen in order to achieve higher magnification.	**02 M** **02 M**
	e	**Give technical specifications of pollution monitoring station and give significance of it.** **Ans:** **Technical specifications of pollution monitoring station: (Any Four)** 1. Portable 2. GSM enabled 3. Auto calibration unit with cross sensitivity reduction technique 4. Monitors criteria pollutants such as SO2, NO2, O3, CO, PM2.5 and PM10	

		5. Also monitors Temperature, Relative Humidity, Barometric pressure and Ultra-Violet Index 6. Command Control & Visualization Dashboard • Intuitive User Interface • Advanced Device Configuration and Management • Dynamic Hierarchical Visualization and reporting • Android Apps • Demographical Analytics • Command Control Support • Enhanced O&M Support **Significance of pollution monitoring station:** Protecting the atmospheric environment involves control of atmospheric emissions as well as an understanding of pollutant dispersion, monitoring emission levels, i.e. concentration in ambient air. To monitor these levels there is pollution monitoring stations i.e Air Quality Monitoring Networks. The main objective of these monitoring stations is to record the concentration levels of atmospheric pollutants in order to define air quality levels and establish action plans if high levels of contamination are detected.	**02 M** **02 M**
5.		**Attempt any <u>TWO</u> of the following:**	**12 M**
	a	**State Photometry law gives its mathematical expression. List any four analytical instrument based on it.** **Ans:** **State Photometry law:** A combination of the two laws, known jointly as the Beer Lambert law, defines the relationship between absorbance (A) and transmittance (T). It states that the concentration of a substance in solution is directly proportional to the 'absorbance'. A, of the solution. **Mathematical expression:** Absorbance A= £ cb, Where A= absorbance (no unit of measurement) £ = molar absorptivity (dm3 mol-1 cm-1) c= molar concentration (mol dm-3) b= path length (cm). It may be noted that £ is a function of wavelength. So, the Beer Lambert Law is true only for light of a single wavelength or monochromatic light. **Analytical instrument: (any four)** 1. Colorimeter 2. Flame photometer 3. Single beam Spectrophotometer 4. Dual beam Spectrophotometer 5. Filter photometer	**02 M** **02 M** **02 M**
	b	**Give biomedical applications (one each)** **i) Incinerator** **ii) Centrifuge** **iii) Autoclave**	

		iv) Freezer **v) Sterilizer** **vi) Hot Air Oven** **Ans:** **Biomedical applications (Any One):** **1. Incinerator :** Burning of wastes produced a) Medical and infectious wastes(Burning of Placenta, Disposable needle syringes, Surgical pads, Hand glows etc which are used in hospital, burn hygienic waste generated daily may be also saline bottles, dressing cottons & dangerous body parts.etc b) Hazardous wastes. **2. Centrifuge:** a) Separation of blood cells from blood (plasma), removal of fibrinogen (serum). b) DNA / RNA separation c) Also used to determine the haematocrit and to separate urinary components. **3. Autoclave:** In medical labs, autoclaves are used to a) Sterilize medical equipment (used to kill microorganisms and spores) b) Glassware, surgical equipment, and medical wastes **4. Freezer:** a) For storing Blood Samples b) Medical samples(tissue cultures) **5. Sterilizer:** Sterilization is used on a) Critical medical equipment/devices(surgical forceps) b) Semi critical medical equipment/devices(endoscopes) c) Non-critical (simple tongue depressors and bedpans) **6. Hot Air Oven:** a) Sterilize N95 masks, Forceps, Scissors b) Dry glassware	**01 M** **01 M** **01 M** **01 M** **01 M**
	c	**With neat diagram describe working of PAGE electrophoresis. List any two applications of the same.** **Ans:**  **Fig: PAGE electrophoresis** **OR**	**02 M**

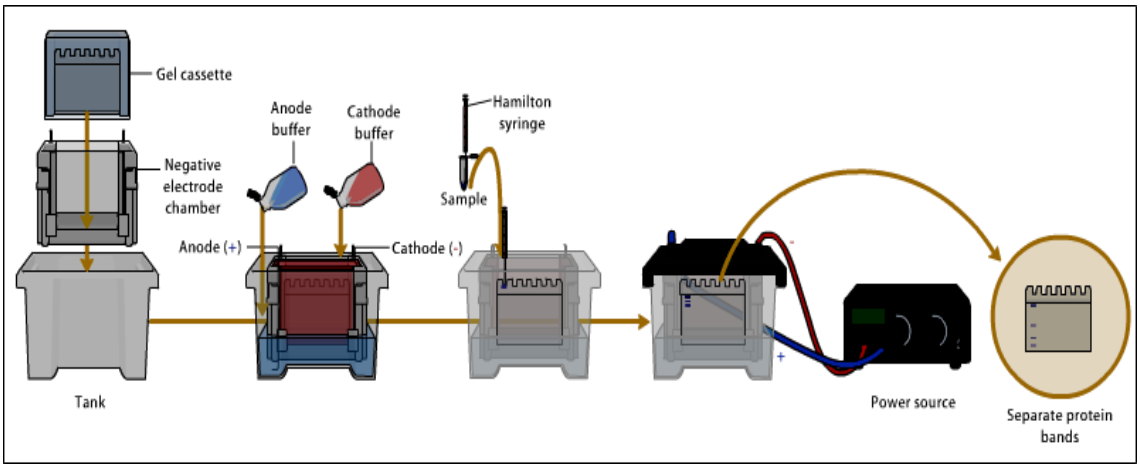


Fig: PAGE electrophoresis

PAGE is an analytical technique to separate proteins based on their molecular weight. Apparatus consists of

- High voltage supply
- Electrodes
- Buffer
- Gel cassette
- Densitometer or scanner

02 M

Electrophoresis may be defined as the migration of the charged particle through a solution under the influence of an external electrical field. Ions that are suspended between two electrodes tends to travel towards the electrodes that bears opposite charges**.** Separation is brought about through molecular sieving technique, based on the molecular size of the substances. Gel material acts as a "molecular sieve". Gel is a colloid in a solid form (99% is water). It is important that the support media is electrically neutral. Different types of gels which can be used are; Agar and A garose gel, Starch, Sephadex, Polyacrylamide gels. A porous gel acts as a sieve by retarding or, in some cases, by completely obstructing the movement of macromolecules while allowing smaller molecules to migrate freely.

Applications (any two)

1. In the separation of DNA fragments for DNA fingerprinting to investigate crime scenes
2. To analyze results of polymerase chain reaction
3. To analyze genes associated with a particular illness
4. In DNA profiling for taxonomy studies to distinguish different species
5. In paternity testing using DNA fingerprinting
6. In the study of structure and function of proteins
7. In the analysis of antibiotic resistance
8. In blotting techniques for analysis of macromolecules
9. In the study of evolutionary relationships by analyzing genetic similarity among populations or species.

02 M

6.		**Attempt any TWO of the following:**	**12 M**
	a	**Differentiate between colorimeter and spectrophotometer (any six points).** **Ans:** **(Any six points)**	**06 M**

SN	Colorimeter	Spectrophotometer
1	It uses fixed wavelengths in the visible range(around 400-700nm)	Can be extended to x-ray, UV light infrared and radiofrequencies
2	Wavelength is selected by using colour filter	Wavelength is selected by using a prism
3	Spectral Bandwidth is Broad band	Spectral Bandwidth is Narrow band
4	It is robust and less expensive and complex	It is more expensive and complex
5	It is less sensitive	It is more sensitive
6	Accuracy is less	Accuracy is more
7	Sample – Larger volume needed	Sample – Small volume needed
8	Spectral Isolation --- filter has to be changed	Spectral Isolation --- Desired wavelength can be adjusted

Table: Difference between colorimeter and spectrophotometer

	b	**Give significance of PH meter. Draw null detector type PH meter. Describe its working.** **Ans:** A pH meter is a scientific instrument that measures the hydrogen-ion activity in water-based solutions, indicating its acidity or alkalinity expressed as pH. The pH meter is used in many applications ranging from laboratory experimentation to quality control.	**02 M**

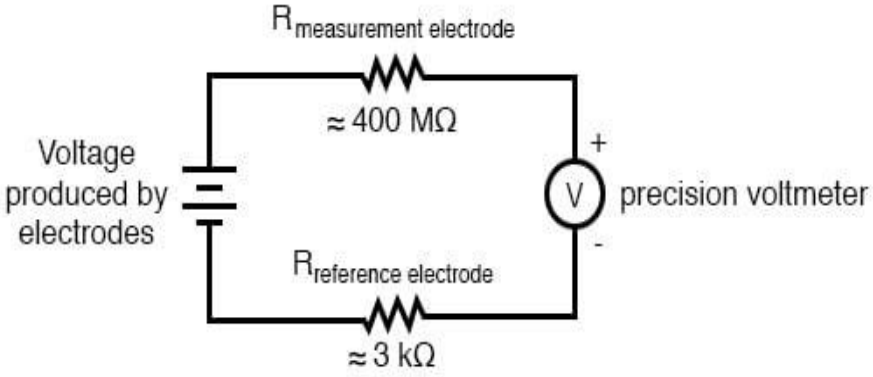
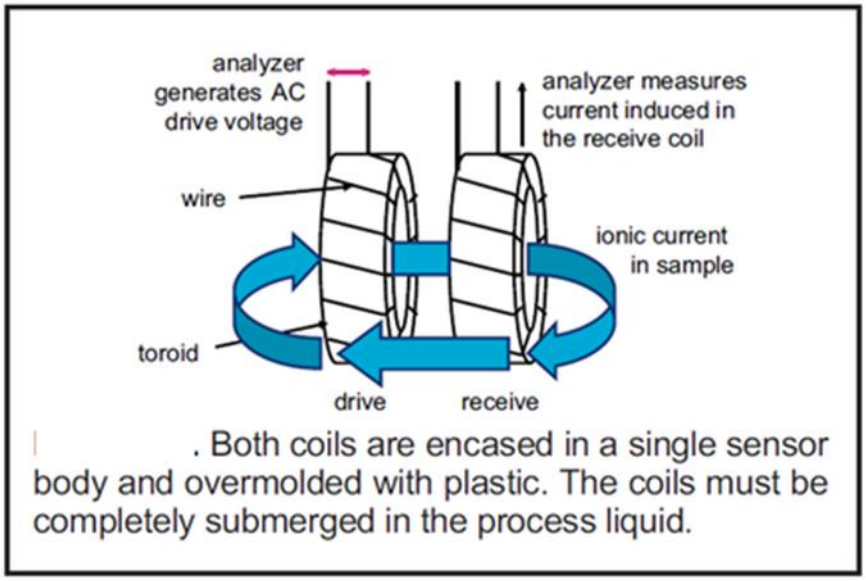


Fig: Null detector type PH meter

02 M

Figure shows the principle of this method in which voltage output between a pair of PH electrodes is measured without drawing any current from the circuit under test. In the circuit the emf developed on the PH electrodes is shown along with series resistors of both the glass electrodes and reference electrodes. The precision voltage can be adjusted

02 M

		until the null detector shows zero. The reading on the voltmeter connected in parallel with precision voltage would show the electrode potential representing the PH of the solution. At the "nulled" detector condition there would be zero current in the PH electrode circuit and therefore no voltage drop across the resistances of either electrode, giving the real electrode voltage at the voltmeter terminals. The PH value is read from the calibrated precision voltage source dial marked as PH unit.	
	c	**Give brief classification of conductivity sensors. Describe inductive conductivity sensor with labeled diagram.** **Ans:** **Classification of conductivity sensors:** 1. 2-Electrode conductivity Sensor 2. 4-Electrode conductivity Sensor 3. Inductive conductivity Sensor  **Fig: Inductive conductivity sensor** An inductive sensor consists of two wire-wound metal toroids encased in a corrosion-resistant plastic body. One toroid is the drive coil, the other is the receive coil. The sensor is immersed in the conductive liquid. The analyzer applies an alternating voltage to the drive coil, which induces a voltage in the liquid surrounding the coil. The voltage causes an ionic current to flow proportional to the conductance of the liquid. The ionic current induces an electronic current in the receive coil, which the analyzer measures. The induced current is directly proportional to the conductance of the solution.	**02 M** **02 M** **02 M**