



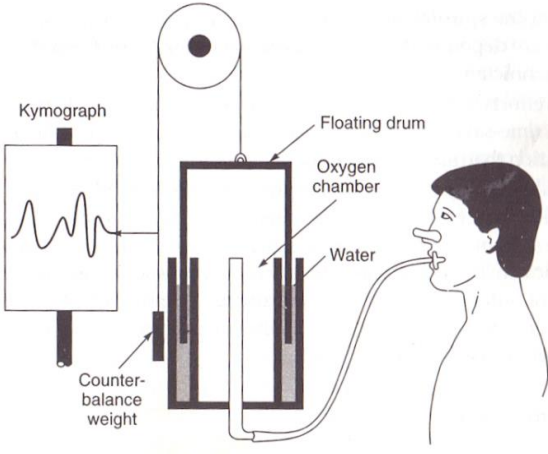
**MODEL ANSWER**  
**SUMMER- 18 EXAMINATION**

**Subject Title: Biomedical instrumentation**

**Subject Code:- 17666**

**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.

Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1	A)	<b>Attempt any THREE :</b>	<b>12 Marks</b>
	a)	<b>Draw neat and labelled block diagram of spirometer. State its use.</b>	<b>4 Marks</b>
	Ans:	<p><b>Block diagram of spirometer :</b></p>  <p><b>Use of spirometer:</b></p> <ul style="list-style-type: none"> <li>• To measure all lung volumes and capacities.</li> <li>• To diagnose asthma, chronic obstructive pulmonary disease (COPD) , Chronic bronchitis, Emphysema, Pulmonary fibrosis other conditions that affect breathing</li> </ul>	<b>2Marks</b>
			<b>2 Marks for any two relevant uses</b>



- To monitor lung condition and check whether a treatment for a chronic lung condition is helping to breathe better.

b) **List any four effects of leakage current on human body.**

**4 Marks**

**Ans:** List of effects of current on human body with increasing current intensity

**4 Marks**

- Threshold of perception: It is approximately about a current 500 micro Amp or 0.5 mA.
- Accepted safe level: It is up to 5 mA. It is not considered harmful although sensation may be unpleasant and painful.
- Maximum let go current: It is in excess of 10mA or 20mA. It can tetantize the arm muscle.
- Danger of ventricular fibrillation: It is for currents above 75 mA. It is a cardiac emergency and if not treated immediately can result in death.
- Contraction of heart (Sustained myocardial contraction): it is for current at excess of 1A or 2A.
- Severe burns and physical injury: It is for current at excess of 10A.
- Danger of respiratory paralysis: It is for current at excess of 100mA onwards.
- Sustained Myocardial contraction: Entire heart muscles contract at current in the range of 1- 6 Amp.

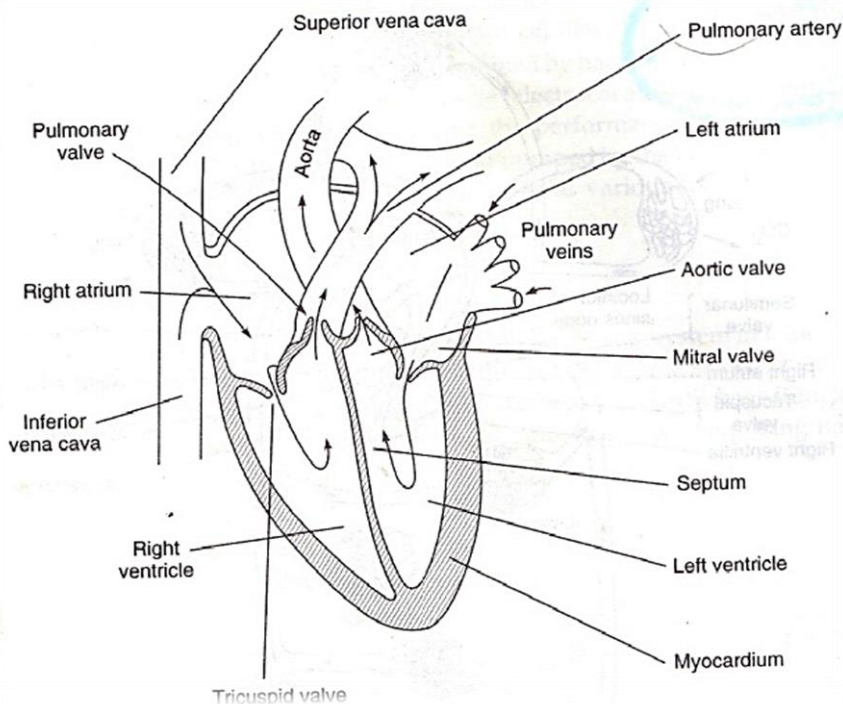
**(1 Mark each –any four)**

c) **Draw a neat labelled diagram of heart and list its parts.**

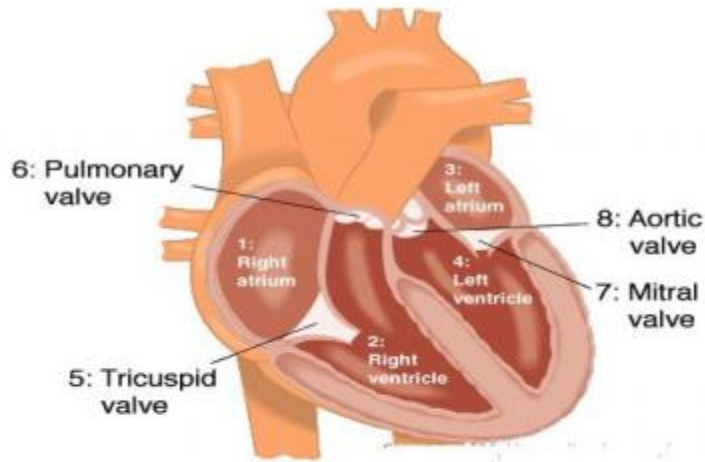
**4 Marks**

**Ans:** **labelled diagram of heart :**

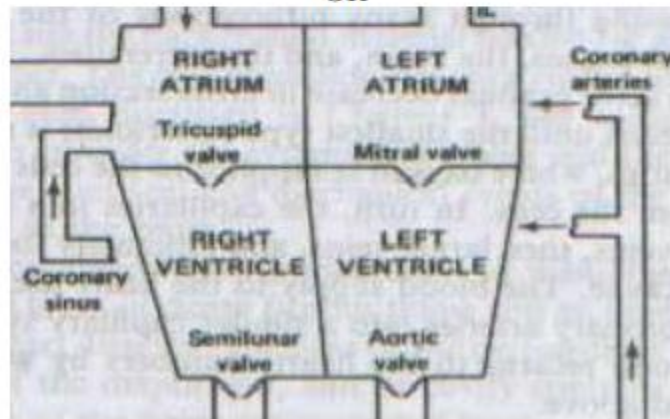
**3 Marks**



OR



OR



**List parts of Heart:**

1. Right Atrium
2. Right ventricle
3. Left Atrium
4. Left ventricle
5. Arteries(Pulmonary, Aorta)
6. Veins(Superior venacava, Inferior Venacava, Pulmonary veins)
7. Valves(Tricuspid ,Bicuspid ,Mitral(Pulmonary) ,Aortic)
8. Septum

**1 Mark**

**d) Define micro-shock and macro-shock.**

**4 Marks**

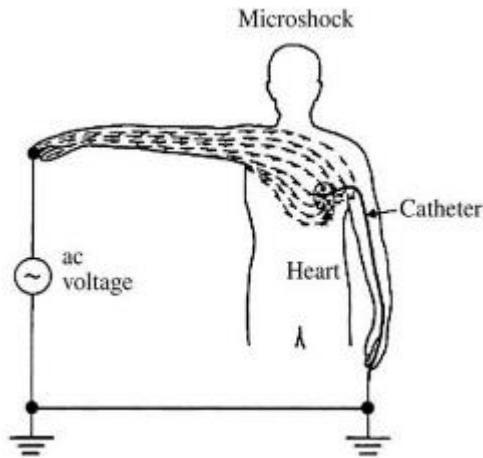
**Ans:** **Micro-shock:** When an interaction of electric current takes place with human body or human body tissues in such a way that one contact is applied directly to the heart & other to body surface, the effect of current applied to the heart is often referred to as micro- shock.

**2 Marks for definition**

OR

The effect of electric current on human body when both conductors or at least one

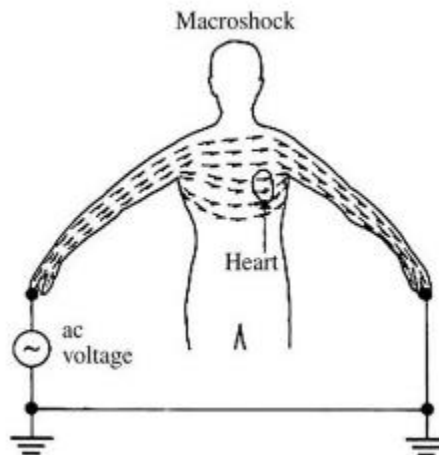
conductor is directly applied to the heart is called micro-shock.



**Macro shock:** When an interaction of electric current takes place with human body or human body tissues in such a way that current is applied through the surface contacts, the effect of current is called macro shock.

Or

The effect of electric current on human body when both contacts are applied through the surface of the body is called macro-shock.



**2 Marks for definition**

**B) Attempt any ONE : 6 Marks**

**a) Compare Internal Pacemaker and External Pacemaker on any two points. Classify various types of pacing modes in Pacemaker. 6 Marks**

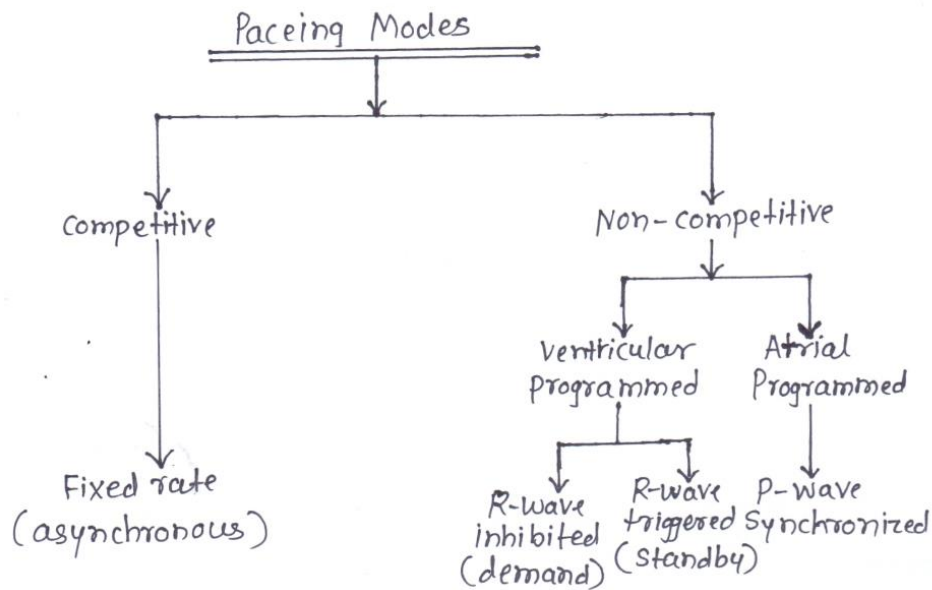
**Ans: 2 Marks (Any 2 points- 1 Marks each)**

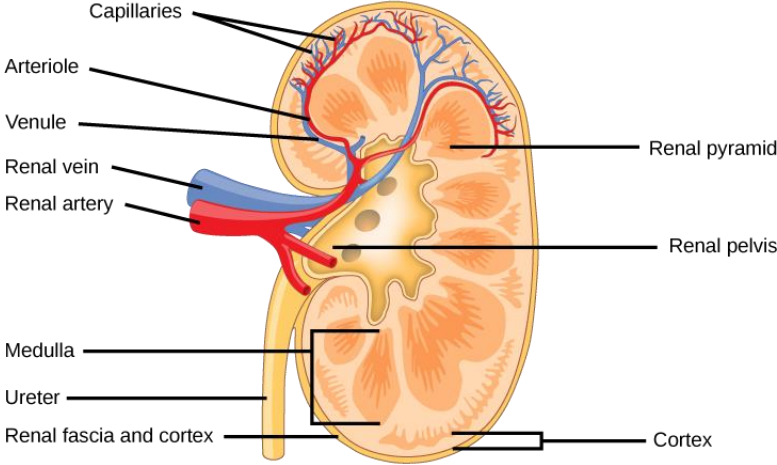


Internal Pacemaker	External pacemaker
i) Entire system (electrodes and pulse generator) is implanted inside the body.	In this electrodes are placed inside the body and pulse generator is implanted outside the body.
ii) It is used on patient having permanent heart block	It is used on patient having temporary heart irregularities.
iii) The electrodes used are myocardial type	iii) The electrodes used are endocardial type
iv) Battery replacement needs minor surgery	Battery replacement is easy and doesn't need surgery
v) Small in size	v) Large in size
vi) It requires an open surgery to place the generator	vi) It doesn't requires an open surgery
vii) It is protected from external disturbances	vii) Not protected from external disturbances

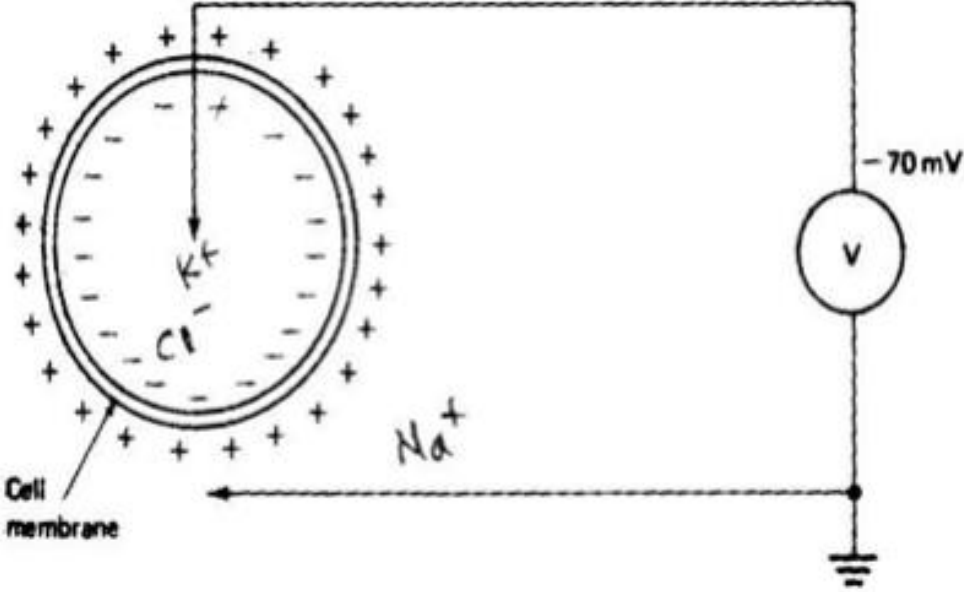
4 Marks

**Classification of pacing modes in Pacemaker:**



b)	<b>Describe the operation of kidney with neat sketch.</b>	<b>6 Marks</b>
Ans:	<p><b>Kidney Structure:</b></p>  <p><b>Operation of kidney:</b> The <b>kidneys</b> are two bean-shaped organs found on the left and right sides of the body . They are located at the back of the abdominal cavity in the retroperitoneal space. They receive blood from the paired renal arteries; blood exits into the paired renal veins. Each kidney is attached to a ureter, a tube that carries excreted urine to the bladder.</p> <p>The nephron is the structural and functional unit of the kidney. Each adult kidney contains around one million nephrons. The nephron utilizes four processes to alter the blood plasma which flows to it:</p> <ul style="list-style-type: none"> <li>• <b>Filtration:</b> It takes place at the renal corpuscle or renal cortex of the kidney where glomeruli of nephrons are situated. It is the process by which cells and large proteins are retained while materials of smaller molecular weights are filtered from the blood to make an ultra filtrate that eventually becomes urine.</li> <li>• <b>Reabsorption :</b> Reabsorption takes place in renal pyramid of the kidney where tubules are situated. It is the transport of molecules from this ultrafiltrate and into the peritubular capillary. It is accomplished via selective receptors on the luminal cell membrane. Water is 65% reabsorbed in the proximal tubule. Electrolytes like sodium, potassium, chloride, calcium, etc also are reabsorbed.</li> <li>• <b>Secretion:</b> It takes place in renal pelvis which is funnel shaped cavity that receives the urine. Secretion is the reverse of reabsorption, molecules are transported from the peritubular capillary through the interstitial fluid, then through the renal tubular cell and into the ultrafiltrate.</li> <li>• <b>Excretion:</b> From pelvis, urine is conveyed from kidney to the urinary bladder. The last step in the processing of the ultrafiltrate is excretion: the ultrafiltrate passes out of the nephron and travels through a tube called the collecting duct, which is part of the <u>collecting duct system</u>, and then to the ureters where it is renamed urine.</li> </ul>	<p><b>3 Marks</b></p> <p><b>Any other relevant diagram may also be given marks</b></p> <p><b>3 Marks</b></p>



Q 2	A)	Attempt any TWO :	16 Marks
	a)	Describe action potential and resting potential with neat diagram & waveform.	8 Marks
	Ans:	<p><b>Resting potential:</b> Surrounding the cell of the body are body fluids. These fluids are conductive solutions containing charged atoms known as ions. The principle ions are sodium (<math>\text{Na}^+</math>), potassium (<math>\text{K}^+</math>) and chloride (<math>\text{Cl}^-</math>).</p> <p>The membrane of excitable cells readily permit entry of (<math>\text{K}^+</math>) and (<math>\text{Cl}^-</math>) ions and restrict the entry of (<math>\text{Na}^+</math>) ions. The inability of sodium to penetrate the membrane results in two conditions. First, the concentration of sodium ions inside the cell is much lower than in the intercellular fluid outside. Since the sodium ions are positive, this would tend to make the outside of the cell more positive than the inside. Second, in an attempt to balance the electric charge, additional potassium ions, which are also positive, enter the cell, causing a higher concentration of <math>\text{K}^+</math> ions on the inside than on the outside. This charge balance cannot be achieved, however because of the concentration imbalance of <math>\text{K}^+</math> ions. Equilibrium is reached with the potential difference across the membrane, negative on the inside and positive on the outside. This membrane potential is called the resting potential of the cell and is maintained until some kind of disturbance upset the equilibrium.</p> <p><b>Diagram of resting potential:</b></p>  <p><b>Action potential:</b> When cell is excited by any external excitation or stimulus then property of cell membrane changes and it allows entry of <math>\text{Na}^+</math> ions. The large number of <math>\text{Na}^+</math> ions tries to enter inside the cell. At the same time <math>\text{K}^+</math> ions try to leave the cell but are unable to move as fast as <math>\text{Na}^+</math> ions. So after some time, potential inside the cell body is more +ve than outside. This developed potential in the cell is called as "action potential" and is approximately around +20mV. The process of changing from resting state to the action potential is called depolarization.</p>	<p>3 Marks</p> <p>(1mark for diagram and 2 marks for explanation)</p> <p>3 Marks</p> <p>1mark for diagram and 2 marks for</p>

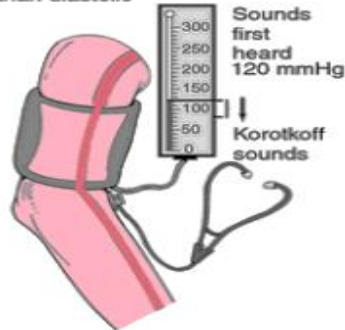




Step 2:

**SYSTOLIC PRESSURE**

Pressure in cuff is released to below systolic but higher than diastolic



Blood spurts into constricted artery

Step 3:

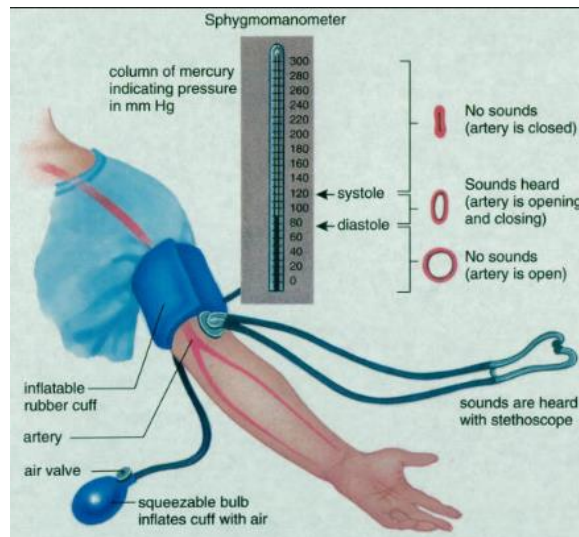
**DIASTOLIC PRESSURE**

Pressure in cuff below diastolic



Blood flows freely

OR

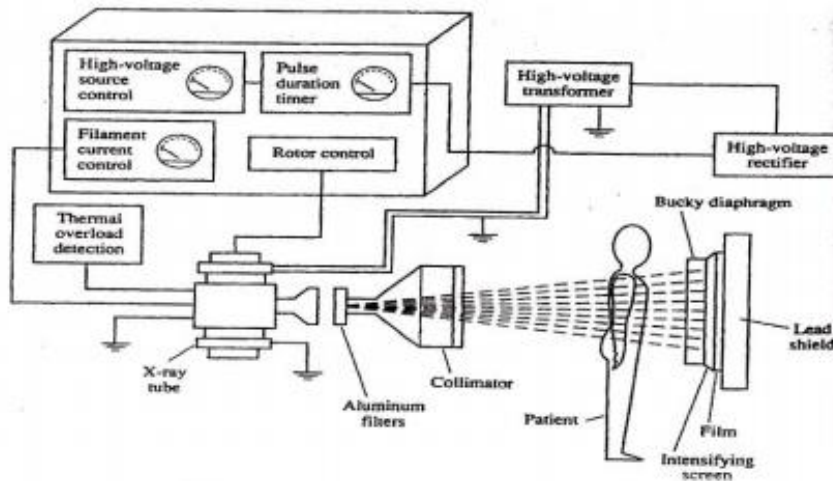


2 Marks

2 Marks

2 marks for any relevant Diagram

	<p><b>Working:</b> The sphygmomanometer consists of an inflatable pressure cuff and a mercury or aneroid manometer to measure the pressure in the cuff. To obtain a BP measurement, the pressure cuff on the upper arm is inflated to a pressure above systolic pressure. At this point, no sounds can be heard through the stethoscope placed over the artery. The pressure in the cuff is slowly released using the needle valve provided. When the cuff pressure falls below systolic pressure, Korotk off sounds can be heard through the stethoscope. The pressure of the cuff, indicated on the manometer when the first Korotk off sound is heard will be systolic blood pressure. As the pressure in the cuff continues to drop, at a particular value, the Korotk off sounds completely disappear. This value is recorded as diastolic pressure.</p> <p><b>Systolic blood pressure:</b> Range of systolic blood pressure in normal adult is in the range of 95-140 mm of Hg with 120 mm of Hg being, average. <b>Diastolic blood pressure:</b> Range of Diastolic blood pressure in normal adult is in the range of 60-90 mm of Hg with 80 mm of Hg being average.</p>	<p><b>4 marks for explanation</b></p> <p><b>1 mark</b></p> <p><b>1 mark</b></p>
<p>c)</p>	<p><b>Explain operation of X-ray machine with its block diagram. List its two application.</b></p>	<p><b>8 Marks</b></p>
<p><b>Ans:</b></p>	<p><b>Block Diagram of X ray :</b></p> <pre> graph TD     Mains[Mains] --- VC[Voltage compensator]     VC --- HTS[High tension supply]     VC --- FS[Filament supply and temperature control]     VC --- V[Voltmeter]     ES[Exposure switch] --- HTS     T[Timer] --- HTS     KV[kV selector] --- HTS     HTS --- R[Rectifier]     R --- MA[mA meter]     MA --- XRT[X-ray tube]     MC[mA control] --- XRT     FS --- XRT     </pre> <p style="text-align: center;"><b>OR</b></p>	<p><b>3 Marks</b> <b>For diagram</b></p>



**Explanation :**

- The block diagram of X ray machine consists of two parts .
- One of them is to produce high voltage which is applied to tubes anode and cathode. It comprises of a high voltage step up transformer followed by rectification. The current through the tube follows the high tension path way and is measured by mA meter. A kV selector switch facilitates change in voltage between the exposures. The voltage is measured with the help of kV meter. The exposure switch controls the timer and thus the duration of application of kV. To compensate mains supply voltage variation, a voltage compensator is included in the circuit.
- The second part is concerned with the control of heating X-Ray tube filament. The filament is heated with 6-12 volts of AC Supply at current of 3-5 A. The filament temperature determines the tube current and therefore the filament temp control is attached to a mA selector. The filament current is controlled by using in the primary side of the filament transformer, a variable choke or rheostat. The rheostat provides a step wise control of mA and is most commonly used in modern machine.

**Application of of X-ray machine:**

- X-ray machines are used in health care for visualising bone structures, during surgeries (especially orthopaedic) to assist surgeons in reattaching broken bones.
- Assisting cardiologists in locating blocked arteries and guiding stent placements or performing angioplasties and for other dense tissues such as tumours.
- Non-medicinal applications include security and material analysis.
- To detect conditions like osteoporosis, tooth decay, broken teeth, etc.
- To detect conditions affecting lungs and respiration.

**3 Marks for explanation**

**2 Marks for any two applications- 1M each**

**Q. 3    A)    Attempt any FOUR :**

**16 Marks**

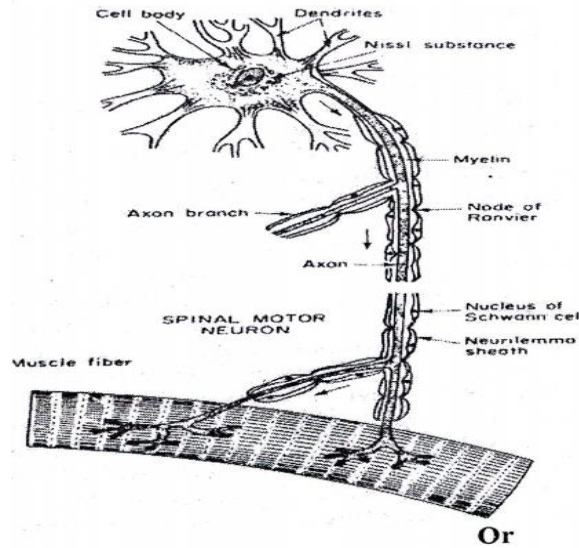
a)

Describe with neat labelled diagram the structure of Neuron and its Functioning.

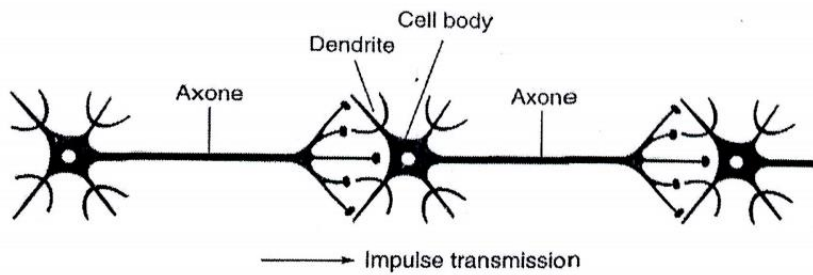
4 Marks

Ans:

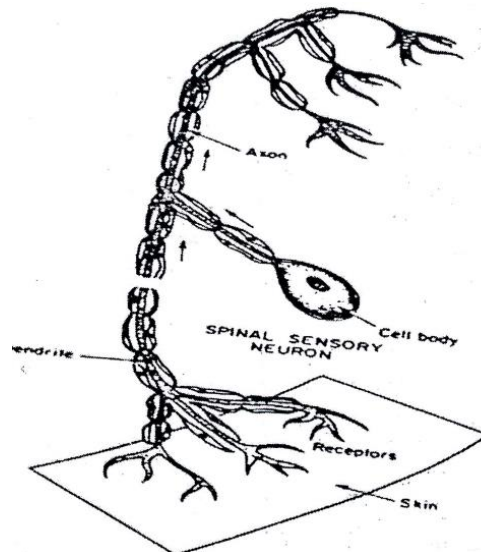
Any one diagram for 2 Marks.



OR



OR



	<p><b>Explanation:</b>  <b>The neuron</b> is the basic unit of the nervous system. A neuron is a single cell with a cell body.  <b>Axon Hillock</b> is the point at which action potentials are usually generated.  <b>Nodes of Ranvier</b> help speed the transmission of information along the nerves.  <b>Afferent nerve</b> carry sensory information from the various parts of the body to the brain and <b>efferent nerves</b> carry signals from the brain to various muscles.</p>	<p><b>2 Marks for relevant explanation</b></p>
<p><b>b)</b></p>	<p><b>Draw the block diagram of EEG machine and state its two specifications.</b></p>	<p><b>4 Marks</b></p>
<p><b>Ans:</b></p>	<p><b>Block Diagram Of EEG Machine:</b></p> <p><b>Specification OF EEG Machine:</b>  <b>Specifications based on following points wrt typical EEG Machine can be considered-</b></p> <ol style="list-style-type: none"> <li>1) <b>Operational Requirement</b></li> <li>2) <b>Technical Specifications</b></li> <li>3) <b>System Configuration Accessories, spares and consumables</b></li> <li>4) <b>Environmental Factors affecting the measurement</b></li> <li>5) <b>Power Supply</b></li> <li>6) <b>Standard Safety and electrical safety parameters</b></li> <li>7) <b>Documentation.</b></li> </ol>	<p><b>Diagram</b>  <b>2 Marks</b></p> <p><b>Any four relevant Specification</b>  <b>2 Marks</b></p>
<p><b>c)</b></p>	<p><b>Explain working of d.c. defibrillation with waveform.</b></p>	<p><b>4 Marks</b></p>
<p><b>Ans:</b></p>	<p><b>Diagram:</b></p>	



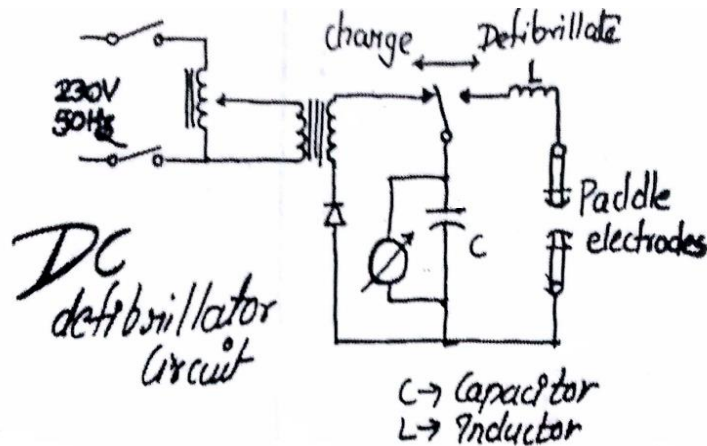
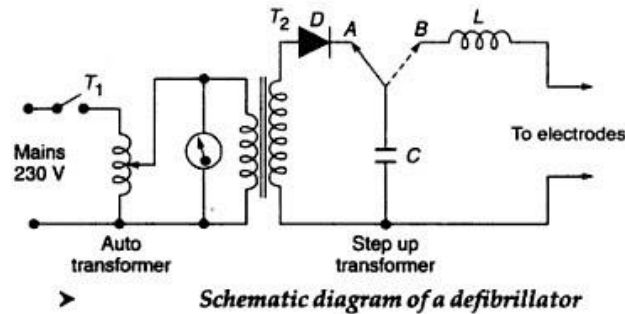


Diagram  
2 Marks

OR

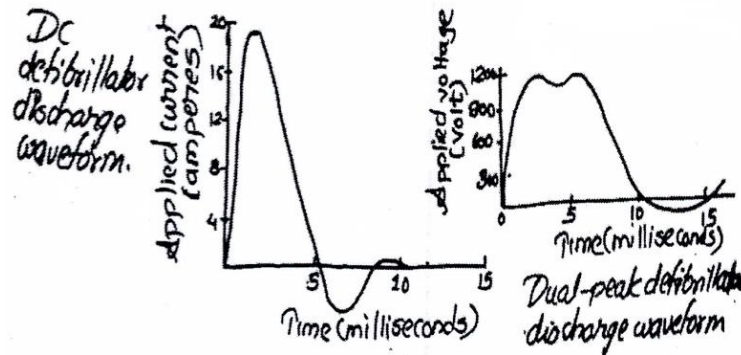


Schematic diagram of a defibrillator

**Explanation:**

In defibrillator a capacitor is charged to a high DC voltage and then rapidly discharged through the paddle electrodes across the chest of the patient. An inductor in the defibrillator is used to shape the wave in order to avoid sharp current spikes. Depending on the energy setting the amount of electrical energy discharged by the capacitor may be of the range 100w and 400w per second.

**Waveforms:**



Explanation  
1 Mark

Waveform  
1 Mark

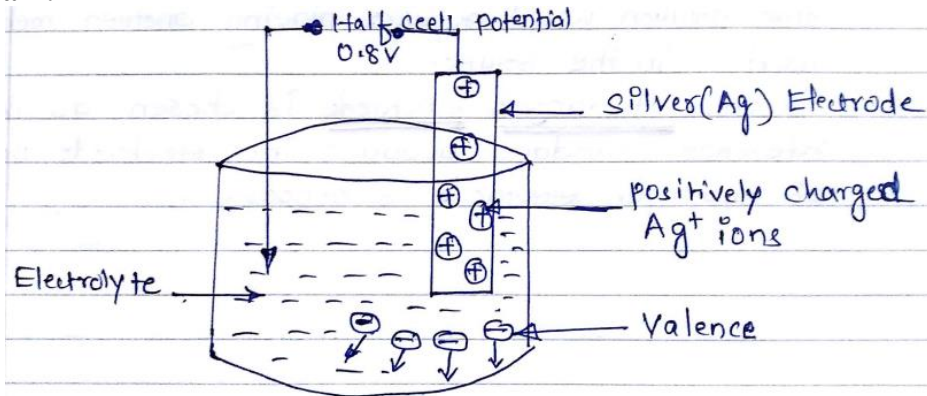
d) Explain electrode-electrolyte interface with the help of diagram.

4 Marks

Ans:



**Diagram:**



**Explanation:**

Since the bioelectric potentials are ionic current, we need transducers which convert ionic current into electric current. These transducers are called **Electrodes**.

When electrode in their simplest form made of piece of metal is placed in or on the body they come in contact with body fluids which may be considered as electrolyte. Due to this contact between metal and electrolyte solution an electro chemical reaction produces a difference of potential between the metal and solution.

The interface of metallic solution with their associated metal results in an electrical potential called **Electrode Potential**.

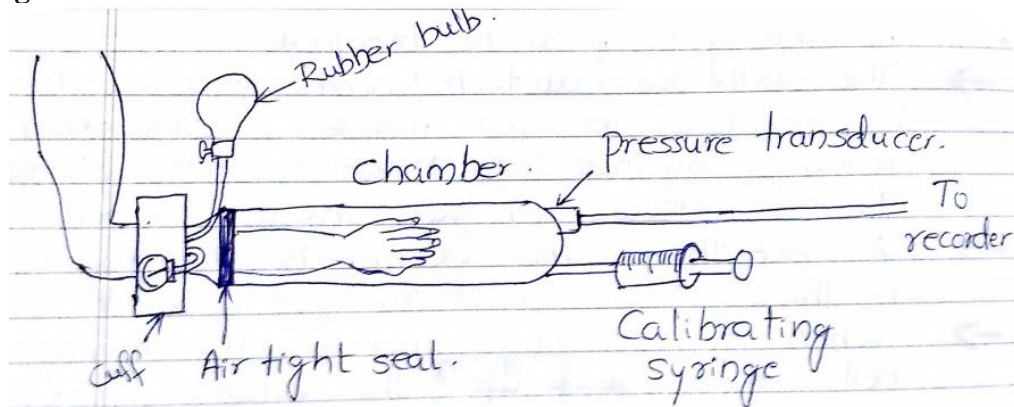
**Diagram 2 Marks**

**Explanation 2 marks**

e) **Explain the working of plethysmograph for measurement of blood flow.**

**4 Marks**

**Ans: Diagram:**



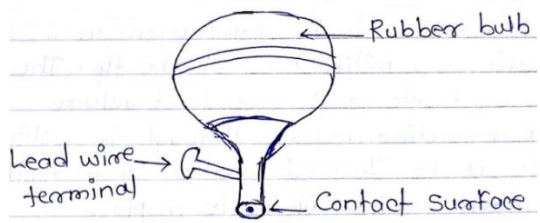

**Explanation:**

The instrument used to measure blood volume changes and in turn blood flow is called as Plethysmograph. It consists of a rigid cup or chamber placed over the limb or digit in which volume changes are to be measured.

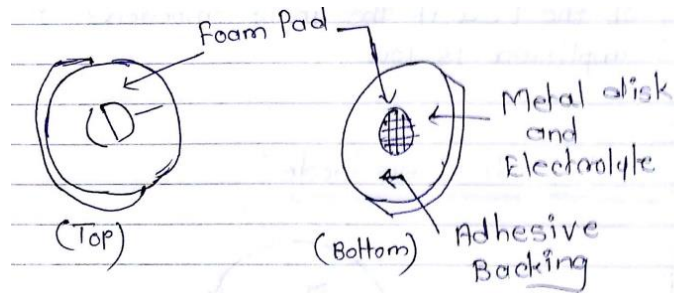
The cup is tightly sealed the member so that any changes of volume in the limb or digit reflect as pressure changes inside the chamber. Either fluid or air can be used to fill the chamber.

A pressure transducer is included to respond to pressure changes within the chamber and to provide a signal that can be calibrated to represent the volume of blood of the

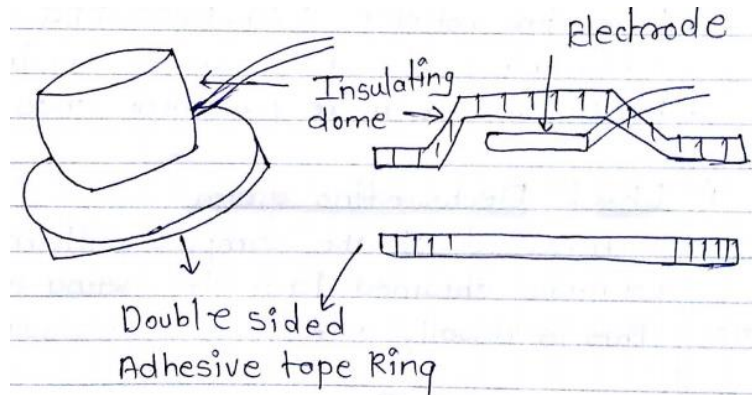
**Diagram 2 marks**

		<p>limb or digit. The base line pressure is calibrated using syringe. If the cuff placed upstream from the seal is not inflated, the output signal is a sequence of pulsations proportional to the individual volume changes with each heartbeat. If the cuff is inflated to a pressure just above venous pressure arterial blood can flow past the cuff but venous blood cannot leave. In this way total amount of blood flowing into the limb can be measured.</p>	<b>Explanation 2 Marks</b>
<b>Q. 4</b>	<b>A)</b>	<b>Attempt any THREE :</b>	<b>12 Marks</b>
	<b>a)</b>	<b>Explain in brief skin surface electrodes.</b>	<b>4 Marks</b>
	<b>Ans:</b>	<p><b>Suction cup Electrode</b></p> <ol style="list-style-type: none"> <li>1. Metals used are German silver [Ni – Ag] or nickel plated steel.</li> <li>2. These electrodes are used for ECG measurements as chest electrodes. In this type only the rim makes contact with the skin.</li> <li>3. These can be placed at a particular locations and then quickly move to next location.</li> <li>4. It consists of hollow, metallic, cylindrical electronic rim that makes contact with the skin at its base and a rubber suction bulb which fits over its top.</li> <li>5. When bulb is released the suction applied against the skin holds the electronic assembly in place.</li> </ol>  <p><b>Metal Disc Electrode</b></p> <ol style="list-style-type: none"> <li>1. This electrode can be made of different metals(Silver, Platinum, Stainless steel)</li> <li>2. Lead wire is soldered or welded to the back surface and protected by a layer of insulating material.</li> <li>3. This electrode is mainly used as a chest electrode for recording ECG.</li> <li>4. This is also used to measure of EMG and EEG.</li> </ol>  <p><b>Disposable electrode</b></p> <ol style="list-style-type: none"> <li>1. It consists of a disc of plastic foam material with a silver plated disc on one side attached to a silver plated snap.</li> </ol>	<b>Any four one mark each</b>

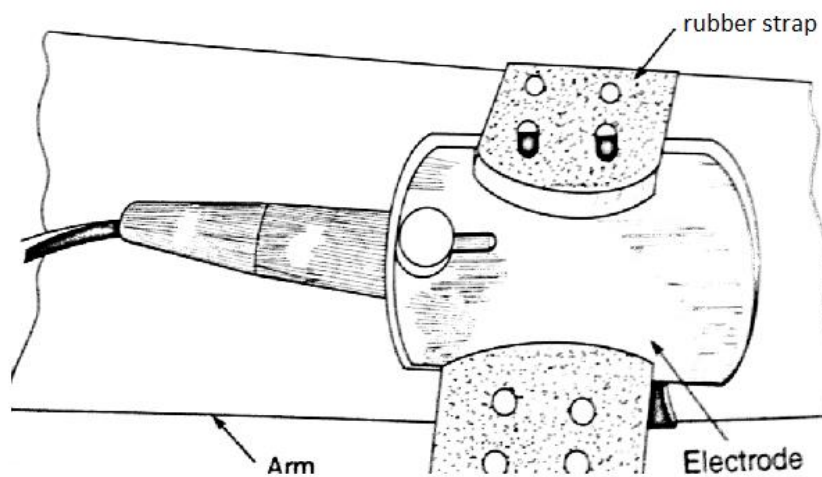
2. A layer of electrolyte paste covers the disk and the electrode side of the foam material is covered with an adhesive material that is compatible with the skin.



OR



**Limb electrodes:** They are rectangular or circular surface electrodes used for ECG recording. Materials used are German silver, nickel silver or nickel plated steel. They are held in position by elastic straps. They are reusable and last for several years.



b) Describe with help of block diagram working of dialysis machine.

4 Marks

Ans:

Diagram:

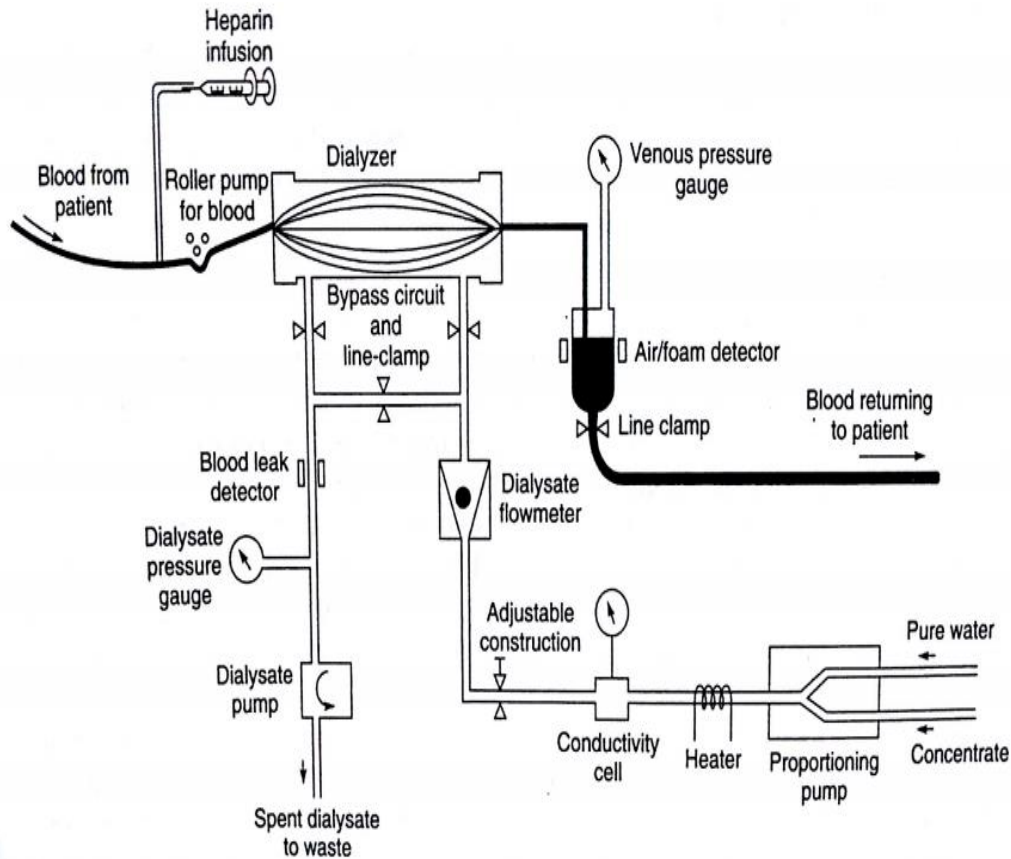


Diagram 2 marks

Explanation 2 Marks

**Explanation:**

In a dialysis machine the blood from the patient through the roller pumps enters the dialyzer unit.

The blood flows in the dialyzer unit from the bottom to top on one side of the semi permeable membrane, while the dialysate which has negligible amount of urea flows from top to bottom. A blood leak detector monitors the dialysate for traces of blood in it.

Heparin pump is usually in form of syringe.

The dialysate is a mixture of concentrate and water in suitable proportion and is passed through proportionating pump. The dialysate temperature is controlled at body temperature.

Conductivity of the dialysate is monitored to verify the accuracy of proportioning.

A flow meter measures the flow of dialysate. Effluents pump help to pass the dialysate to the drain.

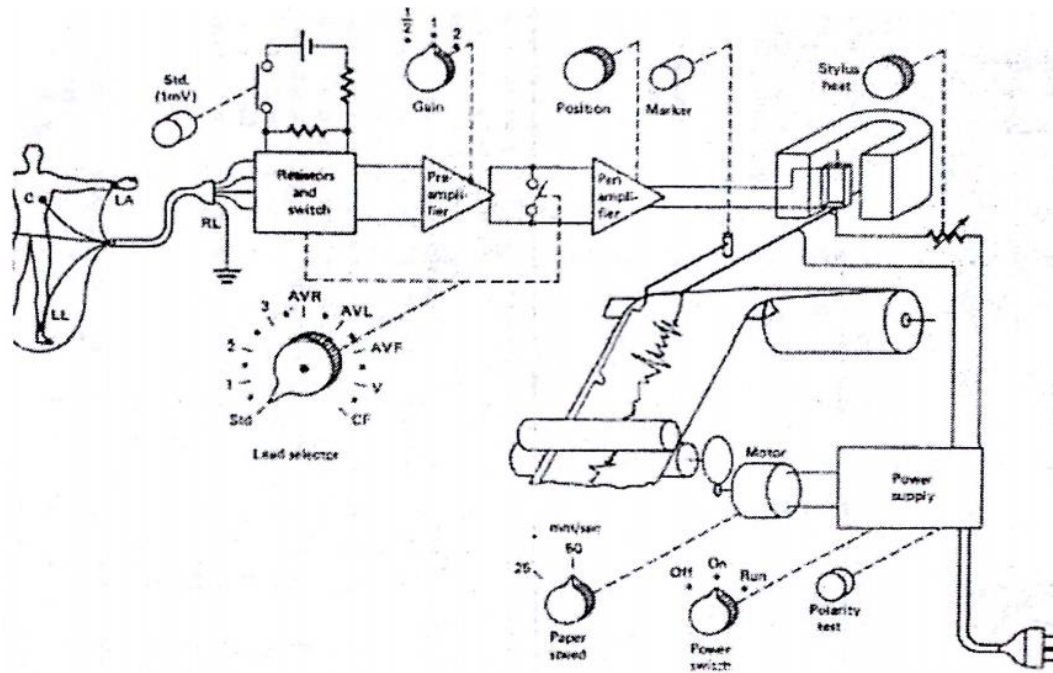
Once through the dialyzer the blood free from urea is returned to the body through the bubble trap which removes the chances of bubble in the blood.

c) Draw neat labelled block diagram of ECG machine. State the difference between unipolar and bipolar lead.

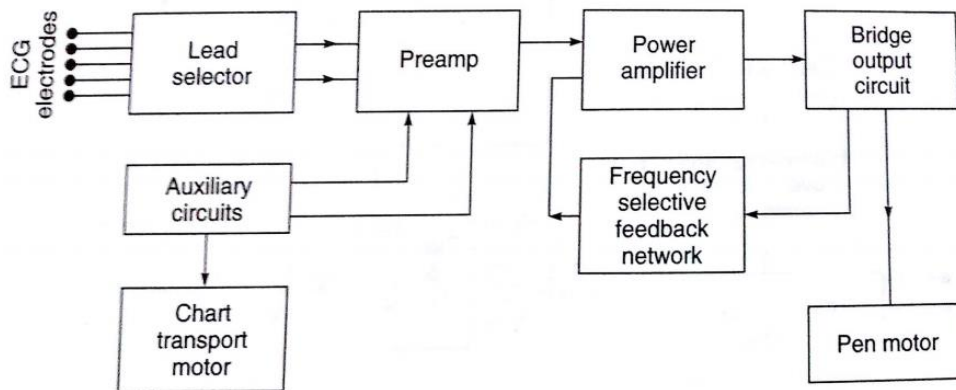
4 Marks

Ans: Diagram:

Diagram  
2 marks



OR



**Difference between Unipolar and Bipolar leads:**

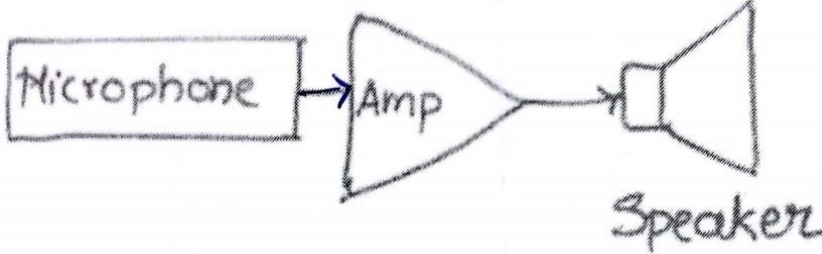
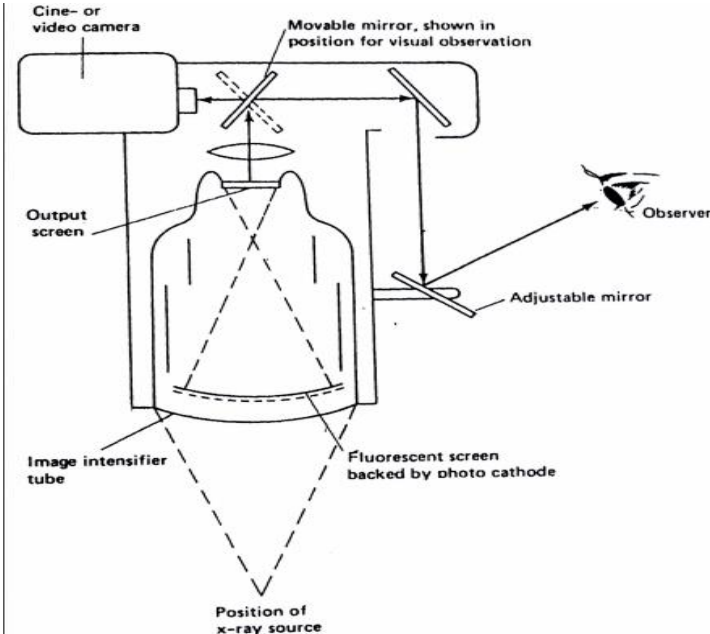
**Unipolar Leads:** For unipolar lead Electrocardiogram is recorded between single exploratory electrode and central terminal. Central terminal is obtained by connecting the remaining active electrodes together through resistors.

**Bipolar leads:**

These leads are called bipolar leads because for each lead the electrocardiogram is recorded from two electrodes and third electrode is not connected. The electrode on the right leg is only for ground reference.

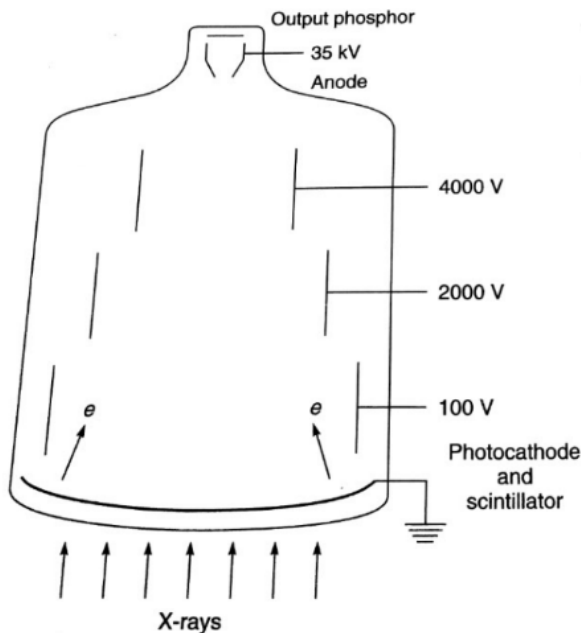
2 Marks.



d)	<p><b>Describe working of measurement of heart sound using Phonocardiograph.</b></p>	<p><b>4 Marks</b></p>
<p><b>Ans:</b></p>	<p><b>Diagram:</b></p>  <p><b>Explanation:</b> The instrument used for graphically recording heart sound is called phonocardiograph. A graphic record of heart sound is called phonocardiogram. The basic transducer for phonocardiograph is a microphone having necessary frequency response ranging from 5Hz to above 1000Hz. An amplifier with similar response characteristics is required which may offer a selective low pass filter to allow the high frequency cut off to be adjusted for noise. The readout of a phonocardiograph is either a high frequency chart recorder or an oscilloscope. Although the normal heart sounds fall within the frequency range of PEN recorders, the high frequency murmurs that are often important in diagnosis require the greater response of phonographic device. Microphone for phonocardiograph are designed to be placed on the chest over the heart.</p>	<p><b>Diagram 1 Mark</b></p> <p><b>Explanation 3 marks</b></p>
<p><b>B) Attempt any ONE :</b></p>		
a)	<p><b>State the significance of image intensifier in X-ray machine.</b></p>	<p><b>6 Marks</b></p>
<p><b>Ans:</b></p>	<p><b>Diagram:</b></p> 	<p><b>Diagram 03 marks</b></p>



OR



**Explanation:**

X-rays cannot be detected or visualized directly by human senses. Indirect methods are needed to visualize the xray images. The faint image of a fluoroscopic screen can be made brighter with the help of an electronic image intensifier. The intensifier tube contains a fluoroscopic screen, the surface of which is coated with a suitable material to act as a photo cathode. The electronic image thus obtained is projected onto a phosphor screen at the other end of the tube by means of an electrostatic lens system. The resulting brightness gain is due to acceleration of the electrons in the lens system and the fact that the output image is smaller than the primary florescent image. TV camera is now used frequently to pick up the intensified image, and then observed on the TV monitor.

**Explanation  
3 marks**

**b) Describe the precaution to minimize electric shock hazards.**

**6 Marks**

- Ans:**
1. In the vicinity of the patient, appliances with three wire power cords should be used.
  2. Provide isolated input circuits on monitoring equipment.
  3. Have periodic checks of ground wire continuity of all equipment.
  4. Connectors for probes and leads should be standardized so that current intended for powering transducers are not given to the leads applied to pick up physiological electrical impulses.
  5. Ground fault circuit interrupters should be used to disconnect the source.
  6. The solid state electronic diagnostic equipment to be so selected that they work on low voltage.
  7. A separate (double) secondary layer of insulation between the chassis and the outer case should be provided to protect personnel from ground fault.
  8. Double insulation reduces leakage current and also protects against both macro

**Any six 1  
mark each.**

		<p>shock and micro shock.</p> <p>9. A potential difference of not more than 5mV should exist between the ground point at the outlet and the ground points at any of the other outlets and any conductive surface in the same area.</p> <p>10. The patient equipment grounding point should be connected individually to all receptacle grounds, metal beds and other conductive services. The resistance of these connections individually should not exceed 0.15 ohms.</p> <p>11. No other apparatus should be put where the patient monitoring equipment is connected.</p> <p>12. The functional controls of the equipment should be clearly marked and operating instructions must be permanently displayed so that they can be familiarized.</p> <p>13. Staff should be trained to recognize potentially hazardous conditions.</p>	
Q.5	A)	<b>Attempt any TWO :</b>	<b>16 Marks</b>
	a)	<b>Explain with the help of block diagram working of Man-Instrument System.</b>	<b>8 Marks</b>
	Ans:	<p>The basic components of the man instrument system are:</p> <ol style="list-style-type: none"> <li><b>1. Subject:</b> The subject is the human being on whom the measurements are made.</li> <li><b>2. Stimulus:</b> Stimulus generates response. The instrumentation used to generate and present this stimulus to the subject is the vital part of man instrument system whenever responses are measured. E.g. visual (flash of light), auditory (a tone), etc.</li> <li><b>3. Transducer:</b> A transducer is device used to produce an electrical signal that is an analog of the phenomenon being measured.</li> <li><b>4. Signal conditioning equipment:</b> This part of the system amplifies, modifies, or in any other ways changes the electric output of the transducer to satisfy the functions of the system and to prepare signals suitable for operating the display or recording equipment that follows.</li> <li><b>5. Display equipment:</b> The input to the display device is the modified electric signal from the signal conditioning equipment which is converted into a form that can be perceived by one o the human’s senses in a meaningful way. E.g. graphic pen recorder for recoding ECG signal.</li> </ol> <p><b>Recording, Data processing, and Transmission:</b> Recording instruments are</p>	<p><b>2 Marks for diagram</b></p> <p><b>6 Marks For explanation</b></p> <p><b>( 1 Mark to explain each block)</b></p> <p><b>Marks may be given to any other relevant block</b></p>



	<p>required to record the desirable information that can be used to transmit or for possible later use. E.g. on line digital computer, recording equipment etc. Control devices: Where it is necessary or desirable to have automatic control of the stimulus, transducers, or any other part of the man instrument system, a control system is incorporated which uses control devices.</p>	<b>diagram and explanation</b>
<b>b)</b>	<b>Explain the principle of ultrasonography. List Various modes of operation. Describe any one mode in brief.</b>	<b>8 Marks</b>
<b>Ans:</b>	<p><b>Principle of Ultrasonography :</b></p> <ol style="list-style-type: none"><li>1. Ultrasound is an imaging modality with noninvasive character and ability to distinguish interfaces between soft tissues.</li><li>3. Ultrasound is not only noninvasive, externally applied but also apparently safe at acoustical intensities in diagnostic equipment.</li><li>4. It gives images of almost entire range of internal organ in abdominal.</li><li>5. Ultrasonic waves or sound waves are associated with frequencies above the audible range and generally extend upward from 20 KHz.</li><li>6. Transmission of ultrasonic wave motion can takes place in different mode like longitudinal and transverse.</li><li>7. Ultrasonic waves are transmitted mechanical vibration and passes only through a medium as a wave motion.</li><li>8. The velocity of propagation of wave motion is determined by density of medium travelling through and stiffness of medium.</li><li>9. Reflection and refraction of ultrasound occurs at an interface between two media having different acoustic impedance.</li><li>10. The principle of imaging or making pictures of internal organs is that of ultrasonic wave reflection.</li><li>11. Ultrasonic waves reflect from the boundary of two medium, just as waves reflect from an object in water. Because the amount of reflection differs in different tissues, it is possible to distinguish between materials and make images of them using ultrasonic waves.</li></ol> <p style="text-align: center;"><b>OR</b></p> <p>Whenever a beam of ultrasound passes from one medium to another, a portion of the sonic energy is reflected and the remainder is refracted as shown in figure below. The amount of energy reflected depends on the difference in density between the two media and the angle at which the transmitted beam strikes the medium. Greater the difference in media , greater will be the amount reflected.</p> <div style="text-align: center;"></div>	<b>3 Marks for principle</b>

### Modes of Ultrasonography:

There are different scanning modes of ultrasonography:

- A scan (Amplitude Scan)
- B scan (Brightness scan)
- M scan (Motion scan)

**A scan:** This mode is the simplest among other methods. The transmitted signals and echo signals are applied to the Y plates of CRT so that they are displayed as vertical deflections on the CRT screen. The vertical sweep is calibrated in units of distance and provides vertical deflections in various ranges depending upon the distance of the interface. Echoencephalogram is typical example of A scan display.

OR

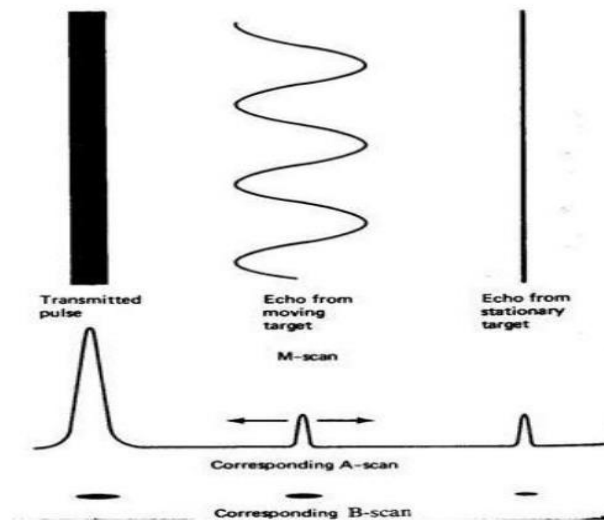
**B scan:** If A scan echoes are rotated electronically  $90^\circ$  towards the viewer, the echoes can be viewed along the horizontal axis as bright and dim dots. The distance between the bright and dim dots represents the depth of tissues and the brightness of the dots represents the strength of the echoes. These dots can be used to obtain a pictorial display of internal organs if position of the probe is continuously moved and the corresponding echoes are obtained.

OR

**M scan:** M scan is very useful in monitoring moving structure inside the body. M scan is basically a combination of A scan and B scan. In this system intensity or brightness of the beam is modulated using received echoes and displayed on horizontal axis with the help of horizontal timing information, that is horizontal sweep. Here the transducer is held stationary so that the movement of the dots along the sweep represent movement of received targets. A stationary target will trace a straight line where as a moving target will trace the pattern of its movement with respect to time.

1 Mark to list all modes

2 Marks for explanation of any mode

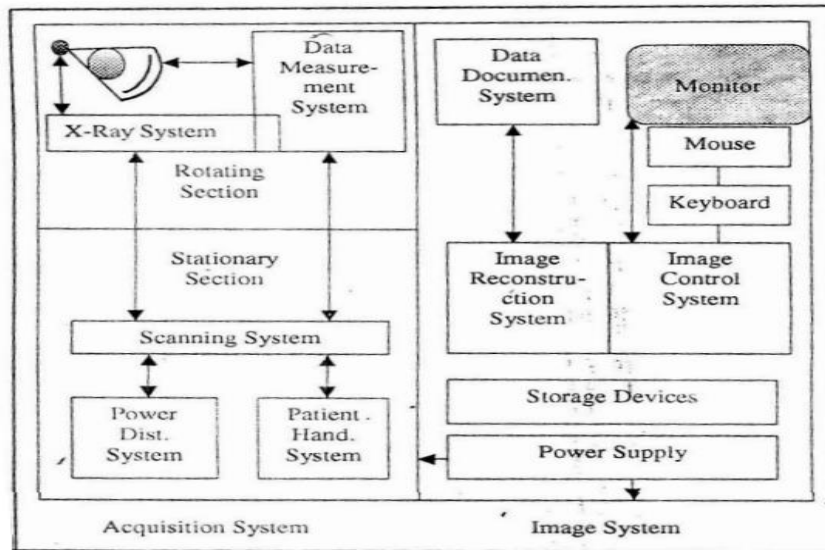


2 marks for diagram

c) Describe with neat labelled diagram the working of CAT scanner.

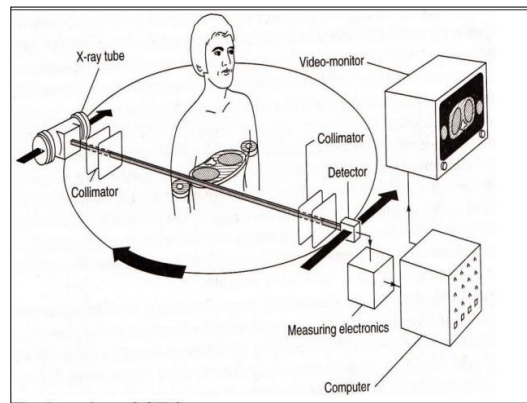
8 Marks

Ans:



4 Marks for diagram

OR



CAT Scanner

1. The CT scanner consists of gantry, patient table, X-ray tube, detector assembly, computer and monitor.
2. X ray tube and detector assembly mounted opposite each other in a rigid gantry rotates once around the patient. The x ray tube emits the x rays at short intervals so that during a full rotation a number of sets of absorption values are collected by detectors.
3. Computer processes this data and produces images of the measured values.
4. The image system controls the function of CT scan such as reconstruction, display and evaluation of the CT image. The image control system is connected to monitor, keyboard, mouse and various storage devices such as disks, tape etc.
5. The image reconstruction system receives measure data and performs the image

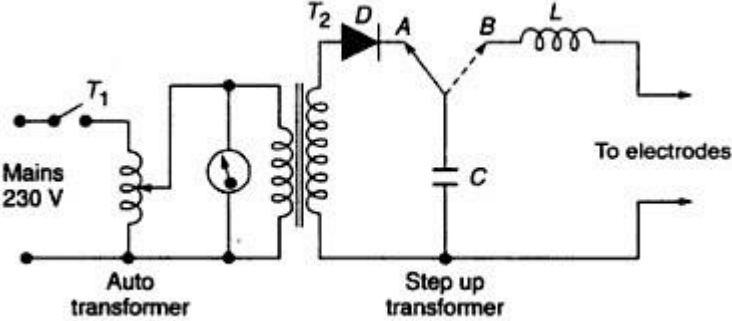
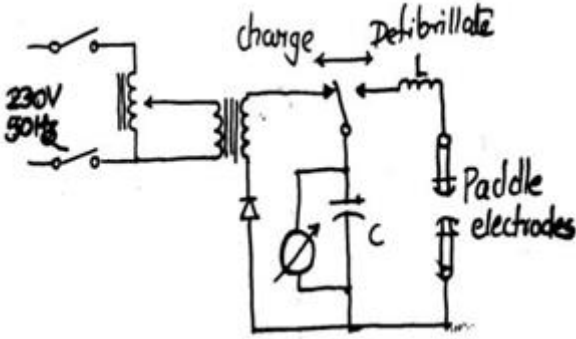
4 Marks for explanation

		<p>reconstruction on it. These images are processed and displayed.</p> <p>6. The data documentation system is connected to the image reconstruction system and is used to photograph the reconstructed CT image.</p> <p>7. Acquisition system acquires the data. The data measurement system belongs to the rotating part of the gantry and contains all the elements to measure the attenuated radiation and to transfer this to image system for reconstruction and display of CT image.</p> <p>8. X ray system also belongs to the rotating part of gantry. The scanning system contains the function of gantry rotation, gantry tilt, to exchange data with X ray system and data measurement.</p> <p>9. The patient handling system consists of patient table, motor for vertical and horizontal drive and system controller.</p> <p>10. The power distribution system provides power supply to all the various systems shown in figure.</p>	
<b>Q.6</b>	<b>A)</b>	<b>Attempt any FOUR :</b>	<b>16 Marks</b>
	<b>a)</b>	<b>Explain how the different heart sounds are generated.</b>	<b>4 Marks</b>
	<b>Ans:</b>	<p>Heart produces four sounds. These sounds are produced due to functioning of different valves present in the heart such as tricuspid, bicuspid valve.</p> <ul style="list-style-type: none"> <li>• 1<sup>st</sup> Heart sound (lub sound – S1): It is generated due to closure of the Atrioventricular valves i.e tricuspid and bicuspid valve. It occurs approximately at the time of QRS complex of the ecg just before ventricular systole.</li> <li>• 2<sup>nd</sup> Heart sound (dub sound – S2): It is generated due to the closing of the semilunar valves at the end of the systole.</li> <li>• 3<sup>rd</sup> Heart sound (S3): It occurs due to rush of blood from the atria into the ventricles, which causes turbulence &amp; some vibrations of ventricular walls.</li> <li>• Atrial Heart sound (S4): It occurs when the atria actually do contract, squeezing the remainder of the blood into the ventricles (Atrial Contraction).</li> <li>• Murmur: Abnormal heart sound due to improper opening of heart valves. The heart sounds are originating due to flow of blood through heart valves in heart chamber</li> </ul>	<p><b>4 marks for explaining four sounds</b></p> <p><b>(Murmur and diagram is optional)</b></p>
	<b>b)</b>	<b>Draw a neat labelled diagram of micro-electrode and explain it.</b>	<b>4 Marks</b>
	<b>Ans:</b>		





	<div data-bbox="500 243 1166 499" data-label="Image"> </div> <ol style="list-style-type: none"> <li>1. Micro electrode is used to measure bioelectric potentials near or within a single cell.</li> <li>2. In this a metal needle is prepared in such a way as to produce a very fine tip so as to penetrate a cell to read the bioelectric potential inside the cell.</li> <li>3. Metal microelectrodes are formed by the electrolytic etching of a thin fine tungsten or stainless steel wire. In addition to etching, the wire is coated with an insulating material except at the thin tip.</li> <li>4. The impedance of the electrode can be lowered by doing some electrolytic process on the tip, where the metal ion interface is taking place.</li> <li>5. Micropipette type is made up of glass. The tip is drawn to a desirable diameter about 1 micrometer.</li> <li>6. The metallic thin film coating is provided outside the thin tip. Resin insulation is provided above this thin film except at the tip.</li> </ol>	<p><b>2 Marks for diagram</b></p> <p><b>2 Marks for explanation</b></p> <p>(Marks should be given for relevant diagram and explanation of Micropipette or Metal microelectrode)</p>
<p>c)</p>	<p><b>Explain Neuronal communication with neat diagram.</b></p>	<p><b>4 Marks</b></p>
<p>Ans:</p>	<div data-bbox="318 1125 1331 1470" data-label="Diagram"> </div> <ol style="list-style-type: none"> <li>1. The Neuron is the basic structural and functional unit of the Nervous system.</li> <li>2. A Neuron is a single cell with a cell body.</li> <li>3. Neuron has small projections known as Dendrites.</li> <li>4. Neuron has one large projection known as Axon. Axon terminals are present at the end of axon.</li> <li>5. Axon hillock is the point at which action potentials are usually generated.</li> <li>6. Nodes of ranvier are present on the axon.</li> <li>7. These nodes help to speed up the transmission of information along the nerves.</li> <li>8. The impulse or action potential generated at the axon hillock passes throughout the axon and then to axon terminals. Here it releases a chemical substance called neuro</li> </ol>	<p><b>2 Marks for diagram</b></p> <p><b>2 Marks for explanation</b></p>

	<p>transmitter which excites the dendrites of the nearby neuron and the impulse is passed from the axon terminals of 1<sup>st</sup> neuron to the dendrites of 2<sup>nd</sup> neuron and the process continues. 10. This act of interconnecting between two neurons is called synapse.</p>	
<p>d)</p>	<p><b>Define fibrillation. Draw the block diagram of defibrillator and explain its working.</b></p>	<p><b>4 Marks</b></p>
<p><b>Ans:</b></p>	<p><b>Fibrillation</b> is the rapid, irregular, and unsynchronized contraction of heart muscle fibers.</p> <div style="text-align: center;">  <p><b>Schematic diagram of a defibrillator</b></p> <p>OR</p>  </div> <ol style="list-style-type: none"> <li>1. It has auto transformer and step -up transformer.</li> <li>2. In defibrillator, high voltage changeover switch is used. When it is at A position, a capacitor is charged to a high DC voltage</li> <li>3. At B position, capacitor is discharged rapidly through the paddle electrodes across the chest of the patient.</li> <li>4. An inductor in the defibrillator is used to shape the waveform in order to avoid sharp current spike.</li> <li>5. Depending on the energy setting the amount of electrical energy discharged by the capacitor may of the range 100W and 400 W per second.</li> </ol>	<p><b>1 Mark for definition</b></p> <p><b>1 Marks for diagram</b></p> <p><b>2 Marks for explanation</b></p>

<b>e)</b>	<b>Explain the physiology of respiration.</b>	<b>4 Marks</b>
<b>Ans:</b>	<div data-bbox="592 283 1079 756" data-label="Image"><p>The diagram illustrates the human respiratory system. It shows the nasal cavity leading to the pharynx, which connects to the larynx and trachea. The trachea branches into two bronchi, one for each lung. The diaphragm is shown below the lungs, and the pleural cavity is indicated between the lungs. Labels include: nasal cavity, pharynx, larynx, trachea, bronchus, right lung, left lung, diaphragm, and pleural cavity.</p></div> <ol style="list-style-type: none"><li>1. The gas exchange process is performed by the lungs and respiratory system. Air, a mix of oxygen and other gases, is inhaled.</li><li>2. In the throat, the trachea, or windpipe, filters the air. The trachea branches into two bronchi (left and right bronchus), tubes that lead to the lungs.</li><li>3. Once in the lungs, oxygen is moved into the bloodstream. Blood carries the oxygen through the body to where it is needed.</li><li>4. Red blood cells collect carbon dioxide from the body's cells and transports it back to the lungs.</li><li>5. An exchange of oxygen and carbon dioxide takes place in the alveoli, small structures within the lungs.</li><li>6. The carbon dioxide, a waste gas, is exhaled and the cycle begins again with the next breath.</li><li>7. The diaphragm is a dome-shaped muscle below the lungs that controls breathing. The diaphragm flattens out and pulls forward, drawing air into the lungs for inhalation. During exhalation the diaphragm expands to force air out of the lungs.</li><li>8. Adults normally take 12 to 20 breaths per minute. Strenuous exercise drives the breath rate up to an average of 45 breaths per minute.</li></ol>	<b>2 Marks for diagram</b>  <b>2 Marks for explanation</b>