TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

DEPARTMENT OF MEDICAL ENGINEERING

DIPLOMA IN MEDICAL ENGINEERING

DME/JAN 2015/S-PT

ECL 2301
DIAGNOSTIC EQUIPMENT

2 hrs

INSTRUCTIONS TO CANDIDATES:

- This paper consists of **FIVE** questions
- Answer question **ONE COMPULSORY** and Attempt any Other **TWO**
- This paper consists of 3 printed pages

Question1

(COMPULSARY)

(a) Explain the working principle of an oil immersion objective

(6 marks)

Solution:

Working principle of an oil immersion objective When a beam of light passes from air into glass it is bent and when it passes back from glass to air it is bent back again to its original direction. This has effect on oil immersion objective and affects the NA of the objective and consequently its resolving power. The bending effect on the objective can be avoided by replacing the air between the specimen and the lens with oil, which has the same optical properties as glass, i.e. immersion oil. By collecting extra oblique light, the oil provides better resolution and a brighter image.

[*award 6 marks*]

(b) i) State the factors that control mean arterial pressure (MAP)

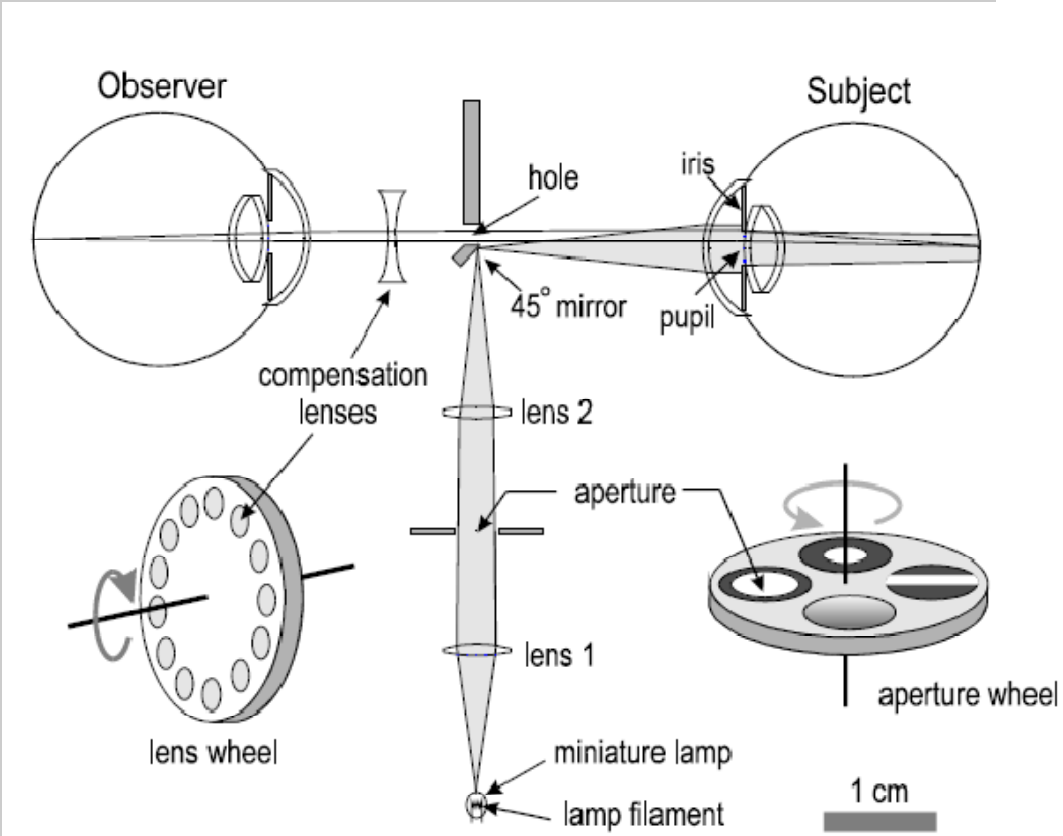
ii) Describe the light path through the Ophthalmoscope

iii) Differentiate between Direct and Indirect ophthalmoscopes

(14 marks)

Solution:

i) [*award 4 marks*]



ii) The illumination system sends light into the subject's eye and consists of an electric incadenscent lamp (about 1/8 inches in diameter), an aperture, two lenses, and a small, 45 mirror. Light rays from the lamp are slightly converged by Lens 1. Lens 2 then focuses the rays so that an image of the lamp filament is produced on the mirror. The aperture between Lens 1 and Lens 2 allows different shapes or colors of illumination. These apertures are mounted on a horizontally oriented thumb-wheel so that different ones can be used at different times. Most ophthalmoscopes have several different apertures including two sizes of clear circular apertures, blue and green circular apertures, and a slit. The aperture is placed at a distance from Lens 2 such that the aperture is in focus on the subjects retina (at least for an emmetrope). This means that the observer will see a fairly-well focused disk of light on the subjects retina when using one of the circular apertures. Since there is an image of the filament on the mirror, it is as though the lamp filament is on the mirror and we can think of light rays as originating from that point. Light rays from the mirror diverge, forming a cone-shaped bundle of rays that enter the subjects eye. The bundle of rays passes through the cornea and anterior chamber. Some of the rays are stopped by the iris, but others pass through the pupil and then to the retina.

[*award 6 marks*]

iii)

[*award 4 marks*]

(c) The following symptoms were reported on a mercury sphygmomanometer. State any **TWO** possible causes of each

i) Black discoloration of mercury

ii) Mercury continues to rise slowly after stopping inflation or abnormally high readings

iii) The mercury does not rise but the cuff inflates

iv) The cuff will not inflate or mercury rise

v) Mercury not at the zero mark before use

(10 marks)

Solution:

i) With time, a black powder (mercuric oxide), forms on the surface.

ii) top leather disc is either too thick or dirty (leather disc restricting the air entering the top of the column)

iii) blockage or a kinked or obstructed tube.

iv) , This indicates that there is a leak.

v) Excess or less mercury

[*award 2 marks for each two points*]

Question2

(a) Describe the following systems of a microscope.

i) magnification system

ii) illumination system

(8 marks)

Solution:

i) Magnification system This comprises: Objectives: - Objectives are components that magnify the image of the specimen to form the primary image. For most routine laboratory work, 10x, 40x, and 100x (oil immersion) objectives are adequate. Eyepiece Eyepiece is the upper optical component that further magnifies the primary image and brings the light rays to a focus at the eye point. It consists of two lenses mounted at the correct distance. It is available in a range of magnifications usually of 4x, 6x, 7x, 10x, 15x and sometimes as high as 20x. N.B: Based on their number of eyepiece, microscopes can be classified as monocular and binocular microscopes.

ii) Illumination system Condenser and iris - Condenser is a large lens with an iris diaphragm. - The condenser lens receives a beam from the light source and passes it into the objective. - The iris is a mechanical device mounted underneath the - Condenser and controls the amount of light entering the condenser. Mirror - Mirror is situated below the condenser and iris. - It reflects the beam of light from the light source up wards through the iris into the condenser. The mirror is used to reflect ray or electrical light. Some microscopes have a built in light source. Sources of illumination Day Light - A Microscope must not be used in direct sun light. - Ordinary daylight may be sufficient for some work. - Daylight, however, is scarcely enough for oil immersion work. Electric light An ordinary 60-watt pearl electric bulb placed about 18 inches from the microscope is sufficient for most routine work. Quartz halogen (quartz iodine) and other high intensity lamps are available and are very good light sources because they give excellent white illumination and do not blacken like ordinary tungsten lamps. Many microscopes are now provided with correctly aligned built-in sources of illumination, which use tungsten or quartz halogen lamps operating on 6, 8 or 12 volts through variable transforms. Filters Light filters are used in the microscope to: - Reduce the intensity of light; - Increase contrast and resolution; - Adjust the color balance of the light to give the best visual effect; - Provide monochromic light; - Absorb light; - Transmit light of selected wavelength; and - Protect the eye from injury caused by ultra-violet light

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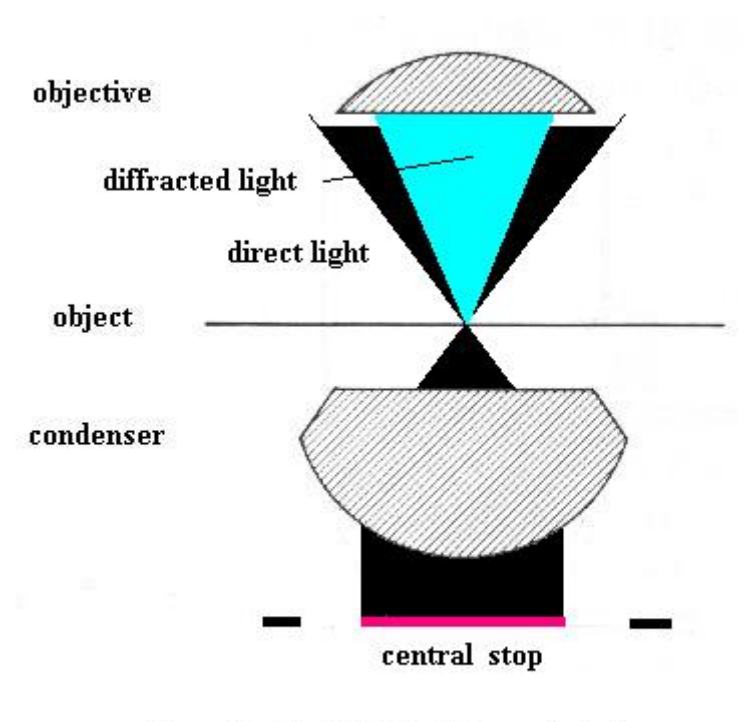
[***award 8 marks***]

(b) With the aid of a diagram, explain the principle of operation of a darkfield microscopy

(12 marks)

Solution:



[award 6 mark]

In dark field microscope, the light enters a special condenser, which has a central blacked out area or a condenser fitted with dark field stop so that the light cannot pass directly through it to enter the objective. Instead, the light is reflected to pass through the outer edge of the condenser lens at a wide angle. The only light entering the eye comes from the microorganisms themselves, with no light entering the eye directly from the light source. In this way, small microorganisms are seen brightly illuminated against a black ground, like stars in a night sky or dust in a shaft of sunlight across a darkened room.

[award 6 mark]

Question3

(a) i) Differiatiate between Oscillometric and Palpation as blood pressure measurement methods

ii) Explain the principle of operation of pulse oximeter in clinical field.

(12 marks)

Solution:

i) Oscillometric detects a small fluctuations in the cuff pressure rather than direct pressure. When blood breaks through the occlusion created by

the inflated cuff, which occurs when the cuff pressure drops below the systolic blood pressure, the walls of the artery begin to vibrate slightly. The vibrations are related to the fact that the blood flow at this point is turbulent, rather than laminar. The on set of the pressure oscillations correlates well with the systolic pressure, while the amplitude peakof oscillation corresponds to the MAP, While The palpation method uses the senses of touch to detect the patient's pulse in the radial artery(wrist). The cuff is inflated until the radial pulse disappers. The operator then slowly releases the pressure in the cuff until a pulse becomes palpable in the radial artery. The pressure at which this occurs is the systolic blood pressure

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[***award 6 marks***]

ii) Pulse Oximetry.
Noninvasive monitoring of SaO2 by pulse oximetry is a rapidly growing practice in many fields of clinical medicine. The most important advantage of this technique is the capability to provide continuous, safe, and effective monitoring of blood oxygenation. Pulse oximetry relies on the detection of time-variant photoplethysmographic (PPG) signals, caused by changes in arterial blood volume associated with cardiac contraction. The SaO2 is derived by analyzing the time-variant changes in absorbance caused by the pulsating arterial blood at the same R and IR wavelength used in conventional invasive-type oximeters. A normalization process is commonly performed by which the pulsatile (ac) component at each wavelength, which results from the expansion and relaxation of the arterial bed, is divided by the corresponding nonpulsatile (dc) component of the PPG, which is composed of the light absorbed by the blood-less tissue and the nonpulsatile portion of the blood compartment. This effective scaling process results in a normalized R/IR ratio, which is dependent on SaO2, but is largely independent of the incident light intensity, skin pigmentation, tissue thickness, and other nonpulsatile variables. Pulse oximeter sensors consist of a pair of small and inexpensive R and IR LEDs and a highly sensitive silicon photodiode. These components are mounted inside a reusable rigid spring-loaded clip, a flexible probe, or a disposable adhesive wrap.

oximeter.pdf

[*award 6 marks*]

(b) i) State any three types of light filters for the microscope
ii) Outline the procedure of setting up phase contrast

(8 marks)

Solution:

i) Neutral filters

ii) Colour filters

iii) Colour connections

iv) Heat absorbing filters

v) Excitation filters

[*award 3 marks*]

i) Illuminate the microscope in the usual way. Turn the required objective in phase and focus it on the specimen

ii) Move the matching annilus into place

iii) Insert the telescope into the microsope in place of the eyepiece and adjust it until the two rings. One bright and one dark are in place

iv) Adjust the condesing screws of the condenser until the bright of the anulus fits excatly innto the darker ring of the phase plate

v) Remove the telescope replace the eyepiece focus and eximine the specimen

[*award 5 marks*]

Question4

(a) Describe the periodic maintenance procedures for diagnostic set

(10 marks)

Solution:

MAINTENANCE PROCEDURES **Opthalmoscope** Optical Clean the lenses by blowing them free from dust with a powerful blower If the lenses are very dirty clean them with methanol and a piece of soft cloth Electrical Check that the batteries and the bulb are in good condition

Mechanical Check for corrosion under the spring at the bottom of the handle If the instrument is not in use for any length of time, remove the batteries to prevent corrosion On removal of batteries that have corroded, thoroughly clean the handle

Otoscopes It is important that the head is airtight. Check this by:-

assembling the instrument complete with the tubing connector and inflation bulb. With a finger over the end of the speculum, gently squeeze the bulb ; there should be no obvious leaks. If there are leaks, check as follows:- Check that the speculum fits properly and that it is not cracked Check that the tubing nipple is screwed in properly Check that the rear lens fits properly, it may be that the lens is cracked or missing. If so replacement may be necessary.

If there is no light: Check the bulb Check the batteries and handle as described for opthalmoscope. Check, with a meter, for continuity between the battery contact and the bulb contact. Use a needle connected to the meter probe to make contact with the bulb contact

A laryngoscope Check that the bulb is screwed in tightly, and that it is a good one. Check that the batteries have power and that the contacts are clean.

(b) Outline the difficulties encountered in using dark-field microscopy

(10 marks)

Solution:

i) Impefect focusing or centering of a darkground condenser

ii) Using a lamp that is not sufficiently bright

iii) Using a slide that is not completely clean

iv) A specimen which is too dense

v) A bubble in the immersion oil or insufficient oil contact

[*award 8 mark*]

Question5

(a) i) Describe the calibration procedure of an aneroid sphygmomanometer
ii) Outline any TWO common faults of aneroid sphygmomanometer

(10marks)

Solution:

Correction of calibration. This is required occasionally, usually as result of the gauge being dropped. It is best done by someone who has experience of aneroid blood pressure machines. However, it may be undertaken by carefully following the instructions below. Each adjustment should be made in very small amounts followed by a check to assess the effect. Start by making sure the pointer is on the zero mark. Remove the glass, then carefully remove the pointer and lift off the dial. You should now see the triangle with concave sides, on one side of which is a pin. In order to correct a non-linear error bend this pin very slightly away or towards the side of the triangle, replace the dial and pointer and run the calibration check again. Repeat this operation until the error has gone. When correcting a linear error bend this pin very slightly along the line of the triangle side. Run the calibration check again and keep adjusting until the error is gone. Broken cover glass. Visit the local watch repairer or make a glass from a thin plastic sheet. After making the adjustments apply a little watch oil to the bearing points.

[*award 6 mark*]

Leaks in the system. If a leak develops in the system wrap the cuff around itself and secure the end. Inflate the system to 250mmHg, watch the pointer. If it slowly drops there is a leak - it is most likely to be in the cuff or inflation bulb. It is fairly rare for a leak to occur in the gauge itself. A small pointed brush with soapy water on it will help find the smallest leak. **Incorrect zero -** the gauge does not return to zero after the cuff has been deflated. On some models, such as the example photographed, there is an adjustment screw to set the zero point. However using this screw requires the instrument to be taken out of the case and the screw may be very stiff. The easiest method of adjusting the zero is by removing the glass from the front of the gauge and carefully taking off the pointer and replacing it in the correct position The pointer can usually be taken off using your finger and thumb nails. If this is not successful find two very small screwdrivers or thin flat pieces of metal and lever the pointer upwards using one on each side. **Calibration check.** Every aneroid blood pressure gauge should be compared with a well maintained mercury sphygmomanometer on a regular basis. Connect the gauges together with a plastic T-piece and connect the third arm to an inflation bulb

[*award 4 mark*]

(b) i) Define the following terms as used in microscopy
i. Resolution
ii. Numerical aperture

ii) The following symptoms were reported on a microscope. Outline any **TWO** possible remedies of each fault

i. microscope will not turn on.
ii. cannot see anything through my microscope.
iii. cannot install my eyepieces.
iv. cannot view anything through the trinocular port on my microscope.

(10marks)

Solution:

i) The power of a lens to reveal detail is referred to as resolving power or resolution of the lens. It is defined as the ability of a lens to reveal closely adjacent structural details as separate and distinct. The resolution of a microscope is partly dependent upon the cone of light collected by the front lens.

ii) The Numerical aperture (NA) is an optical constant. It is defined as the product of the refractive index of the medium outside the lens (n) and the sine of half the angle of the cone of light absorbed by the front lens of the objective (u) i.e

[***award 2 mark***]

First, check to see if your microscope is plugged in. Secondly, check to see if the bulbs are installed correctly: You may have to install or reinstall the microscope bulb. Not all microscopes are shipped with the bulbs already installed. If the bulbs are installed, check to make sure they arent loose, which sometimes happens during shipment. Have you examined all power adjustments? Most microscopes have rocker switches located on the back, sides and the top to control whether the microscope receives power or not; also, most have dials that control the dimness or intensity of the light. Is the fuse in good condition? All microscopes (with cords) have fuses that can be accessed from the outside of the microscope. Depending on the your microscope model, you will either find the fuse on the bottom or back of the microscope. If the glass case of the fuse appears discolored or burned, or you can see broken pieces of the fuse element, this means the fuse is not working. Replacing the fuse will fix this problem. If your microscope blows its replacement fuse quickly, please contact one of our microscope technicians for repair.

Make sure you have removed the protective coverings Have you installed the eyepieces? If not, install your eyepieces (Not sure how? See instructions below)

Have you removed the protective covers from the eye ports? If not, pull out protective covers. Are their retaining screws obstructing this installation? If so, retract with a small slotted screwdriver, such as an eyeglass screwdriver or penknife. Be careful not to scratch the finish on the eyepiece tubes.

Is a black protective cover obstructing your view? If so, remove the protective covering. Is there a silver pull or lever on the side or front of your microscope head? If so, either slide the lever back and forth or pull and push the silver

pull. This will transfer the image from the eye ports to the trinocular port. Are you attempting to look through the trinocular port without an eyepiece? The trinocular port does not contain an optic for viewing. You may purchase an eyepiece ocular to facilitate this type of use if necessary. Typically the trinocular port is used for digital camera attachments that do not require an eyepiece ocular.

[***award 8 mark***]