5th INTERNATIONAL JUNIOR SCIENCE OLYMPIAD

EXPERIMENTAL EXAMINATION
December 13, 2008

Important Remarks

1. While you are in the laboratory, you should wear safety spectacles at all times.
2. Eating of any kind of food is strictly prohibited in the laboratory. If necessary, you may ask Lab Assistant and take a snack break nearby the laboratory.
3. Participants are expected to work safely, to behave socially and to keep equipment and work environment clean. When carrying out discussions with your teammates, keep your voice low.
4. Do not leave the examination room until you have permission to do so. Ask Lab Assistant if you need to use the bathroom.
5. **Work may only begin when the start signal is given.**
6. You have **3 hours and 30 minutes** to complete the experimental tasks, and record your results on the answer sheets. There will be a pre-warning 30 minutes before the end of your time. You must stop your work immediately after the stop command is given. **A delay in doing this by 5 minutes will lead to zero points for the task.**
7. Be sure that your team has a complete set of the experimental examination (3 copies) and 4 types (2 for Experiment I, 1 for Experiment II, and 1 for Experiment III) of answer sheets (1 white copy for workout and 1 yellow copy for submission). **Submit only the yellow answer sheets.**
8. **Use only the pen and calculator provided.**
9. Team code and student codes must be written on every page of the final answer sheets. **Each team member must sign on the front page of the final answer sheets.**
10. All results must be written in the designated boxes on the answer sheets. Data written elsewhere will not be graded.
11. After completing the task, put all the equipments back to its original place.
12. **After the stop command is given, put ONLY the final answer sheets (one copy) on top of the envelope on the desk. Wait for the Lab Assistant to check and collect it. You can take the other papers with you.**

Formatted: Font: Bold

Deleted: kinds

Deleted: 1

Deleted: copy

Deleted: each

Deleted: **Use the white answer sheet for Question I-2 of the Experiment I.**

EXAMINATION RULES

Deleted:

1. All competitors must be present at the front of examination room ten minutes before the examination starts.

2. No competitors are allowed to bring any tools except his/her personal medicine or any personal medical equipment.

3. Each competitor has to sit according to his or her designated desk.

4. Before the examination starts, each competitor has to check the stationary and any tools (pen, ruler, calculator) provided by the organizer.

5. Each competitor has to check the question and answer sheets. Raise your hand, if you find any missing sheets. Start after the bell.

6. During the examination, competitors are not allowed to leave the examination room except for emergency case and for that the examination supervisor will accompany them.

7. The competitors are not allowed to bother other competitor and disturb the examination. In case any assistance is needed, a competitor may raise his/her hand and the nearest supervisor will come to help.

8. There will be no question or discussion about the examination problems. The competitor must stay at their desk until the time allocated for the examination is over, although he/she has finished the examination earlier or does not want to continue working.

9. At the end of the examination time there will be a signal (the ringing of a bell). You are not allowed to write anything on the answer sheet, after the allocated time is over. All competitors must leave the room quietly. The question and answer sheets must be put neatly on your desk.

A. Introduction

Many species of squid are popular as food in cuisines as diverse as Korean and Italian. In English-speaking countries, squid as food is often known by the Italian word calamari. Individual species of squid are found abundantly in certain areas, and provide large catches for fisheries. The body of squid can be stuffed whole, cut into flat pieces or sliced into rings. The arms, tentacles and ink are also edible; in fact, the only parts of the squid that are not eaten are its jaw and gladius (pen).

Squids are marine cephalopods of the order Teuthida, which comprises around 300 species. Like all other cephalopods, squid have a distinct head, bilateral symmetry, a mantle, and arms.

Deleted: Squid, like cuttlefish, have eight arms and two tentacles arranged in pairs.

The main body mass of the squid is enclosed in the mantle, which has a swimming fin along each side. It should be noted that these fins, unlike in other marine organisms, are not the main source of locomotion in most species. The hook is a hard but flexible structure which connects the mantle to the head. The skin of the squid is covered in chromatophores, which enable the squid to change color to suit its surroundings. The underside of the squid is also generally lighter in color than the topside, in order to provide camouflage from both prey and predator. Squid has 10 arms: 8 arms with suckers and the other 2 arms are a pair of long retractile tentacles.

Deleted: ambulation

Under the body are openings to the mantle cavity, which contains the gills (ctenidia) and openings to the excretory and reproductive systems. At the front of the mantle cavity lies the funnel, which the squid uses for locomotion via precise jet propulsion. In this form of locomotion, water is sucked into the mantle cavity and expelled out of the funnel in a fast, strong jet. The direction of the funnel can be changed, in order to suit the direction of travel. Inside the mantle cavity, beyond the funnel, lies the visceral mass of the squid, which is covered by a thin, membranous epidermis. Under this are all the major internal organs of the squid.

Deleted: siphon

Deleted:

Squid have three hearts. Two gill hearts surround the larger systemic heart that pumps blood around the body. The hearts have a faint greenish appearance and are surrounded by the renal sacs - the main excretory system of the squid. Squid, like all cephalopods, have complex digestive systems. Food is transported into a muscular stomach, found roughly in the midpoint of the visceral mass. The bolus (ball of food) is then transported into the cecum for digestion. The cecum, a long, white organ, is found next to the ovary or testis. Finally, food moves through the digestive gland. This organ adds digestive juice to the food and absorbs nutrients. It is found at the funnel end of the squid. The giant axon of the squid, which may be up to 1 mm in diameter in some larger species, stimulates the mantle and controls part of the jet propulsion system.

Unlike vertebrates that change the shape of their lens to focus on objects near or distant, squid use their ciliary muscles to draw the lens in to see distant objects and leave the lens relaxed to focus on objects close to them.

B. Objectives (They are not necessarily to be solved in sequence.)

Experiment I. To observe the anatomic morphology of squid and indicate the function of each organ.

Experiment II. To investigate black ink samples using chromatography.

Experiment III. To assess the relationship between the distance of the object from the lens and the distance of the image from the lens.

C. Apparatus and Materials Needed

General: (You can take all these items with you when you finish.)

Pencil 2 each

Pencil sharpener 1 each

Tissue paper 1 box

Disposable gloves

30 cm ruler 1 each

Calculator 1 each

Safety aprons 1 each/person

Safety glasses 1 each/person

Experiment I: Anatomy

Dissecting Tool Set containing forceps, scissors, etc.

Atlas of squid anatomy

Deleted: have

Deleted: lus

Deleted: goes to the digestive gland,

Deleted: Many species of squid are popular as food in cuisines as diverse as Korean and Italian. In English-speaking countries, squid as food is often known by the Italian word calamari. Individual species of squid are found abundantly in certain areas, and provide large catches for fisheries. The body of squid can be stuffed whole, cut into flat pieces or sliced into rings. The arms, tentacles and ink are also edible; in fact, the only parts of the squid that are not eaten are its beak and gladius (pen). ¶

Formatted: Indent: Left: 0", First line: 0"

Deleted: implicate

Deleted: various

Deleted: s

Deleted: →

Deleted: characterize

Formatted: Highlight

Deleted: 1

Deleted: EA

Deleted: EA

Deleted: 10 cm ruler 1 EA,

Deleted: EA

Deleted: EA

Deleted: EA

Deleted: EA

Deleted: Part

Dissecting pan lined with rubber plate

Squids in the container (two each)

Experiment II: Chromatography

Sample #1 ~ #6, each in 2 mL vial

25 mL graduated cylinder 1 each

Beaker 300 mL 1 each

Beaker 500 mL 1 each

Watch glass 2

Chromatography paper (2.0 x 40 cm) 1 each

TLC plate (Silica gel on glass, 5.0 x 10 cm) 2 each

(Be careful not to touch the silica surface with your finger.)

Capillary tube 1 each

Toothpicks

Forceps 1 each

Ethanol (99.9%) 20 mL

Distilled water 50 mL

Pasteur pipette 2 each

Tape

Marker pen (black) 1 each

Part III: Eye

Optical rail

Light source

Object (arrow marked plate) and optical mount 1 each

Lens and optical mount 1 each

Screen 2 each and optical mount 1

Black paper for light shielding

Additional graph papers for practice

Deleted: EA

Deleted: **Part**

Deleted: EA

Deleted: EA

Deleted: EA

Deleted: E

Deleted: EA

Deleted: EA

Deleted: Filter paper (90mm dia. circle) 1 EA¶
Tweezers

Deleted: EA

Deleted: 1

Deleted: EA

Formatted: Line spacing: Multiple 1.6 li

Deleted: EA

Deleted: (type B)

Deleted: EA

Deleted: EA¶

Formatted: Font: Times New Roman, 12 pt

D. Experiments and Questions

Experiment I: Anatomy

Procedures:

1. Inspect your dissecting tool set and pan to check if everything is provided. If you have missing items, notify the assistant right away.
2. Wear safety apron, gloves, and safety glasses at all times for your safety.
3. Perform the anatomy experiment as indicated.
4. Once your test is completed sign the answer sheet first, then raise your hand to ask the assistant to take a picture of your answer sheet.
   - If you need assistance at any time, raise your hand and wait for the assistant's attention.

Experiments and Questions:

Procedures of Internal Anatomy of Squid

1. Remove squid from its container and transfer to a dissecting pan.
2. Make a biological drawing of the external body of the squid to scale. (Labels are not required.)
3. Use scissors or scalpels for your dissection to expose the internal organs.

   Caution: Don't cut too deep or the internal organs will be damaged. **Scalpels are extremely sharp! When you open your squid, hold it so that the scalpel will not slice your palm or fingers.**
4. Identify each organ listed on the answer sheet by comparing with atlas figure as you proceed with the dissection.
5. Remove the organs and place them in the correct boxes on the answer sheet.
6. **Ask assistants to grade and take a picture of the answer sheet.**
7. Clean up your dissecting pan. Dispose of the bio-materials into the container.

Questions:

I-1) Draw the external features of the squid. Use the answer sheet I. (2 points)

I-2) Dissect the organs and display them on the answer sheet in the corresponding boxes indicated below. (0.5 point each) Use the answer sheet I-2.

(An assistant will take a picture of this sheet, including your team ID and signature after confirming them.)

I-3) Match each organ with its correct function by writing down the corresponding number only. Use the answer sheet I. (0.5 point each)

Deleted: Part
Deleted: TA
Deleted: goggles
Deleted: TA
Deleted: TA's
Deleted: Sketch
Deleted: as much as you observe
Deleted: , but don't cut too deep or the internal organs will be damaged.
Deleted: every
Deleted: individual
Deleted: Take out
Deleted: put
Formatted: Font: Bold, Underline
Deleted: TA
Deleted: for
Formatted: Font: Bold, Underline
Deleted: ing
Formatted: Font: Bold, Underline
Deleted: ing
Formatted: Font: Bold, Underline
Deleted: _
Formatted: Font: Bold, Underline
Deleted: Trash
Deleted:
Formatted: Font: Times New Roman
Deleted: Sketch
Deleted: and internal organs
Deleted: as you observe
Deleted: TA
Formatted: Font: Not Bold
Formatted: Underline
Formatted: Underline
Deleted: According to your anatomy results, indicate the function of each organs from the example
Deleted: ¶

Experiment II: Chromatography

Deleted: Part

Squid ink is still used today as the basis of the color known to painters as Sepia. Sepia ink was used to paint even in the 4th century BC. Today the chemical composition of squid ink is studied using chromatography. This method separates molecules within a mixture by type, allowing comparisons of molecules present in inks from different species.

Chromatography is a method used for separating organic or inorganic compounds. All forms of chromatography work on the same principle. They have a stationary phase (a solid, or a liquid supported on a solid) and a mobile phase (a liquid or a gas). The mobile phase flows through the stationary phase and carries the components of the samples to be studied. Different components travel at different rates.

Deleted: so that they can be analyzed and studied.

Deleted: mixture

Deleted: with it

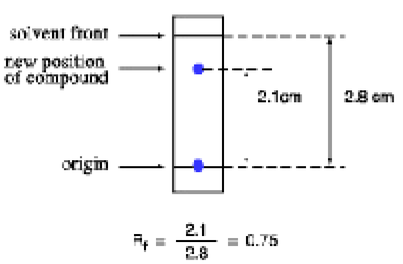
The retention factor (R_f) is a quantitative indication of how far a particular compound travels with the mobile phase (solvent). The R_f value is a good indicator of whether an unknown compound and a known compound are similar, if not identical. For example, The retention factor, Rf, of a specific compound is defined as D1 / D2, where

Deleted: in

Deleted: a particular

D1 = distance that compound traveled, measured from center of the band of compound to the point where the sample was applied

D2 = the distance between the solvent front to the origin



Question II-1. Paper Chromatography.

Prepare two paper chromatograms for the ink samples #1 and #2.

1. Cut a strip of chromatography paper about 10 cm long for two ink samples we want to compare.
2. Use a pencil to draw a line near the bottom of each paper.
3. Place a very small drop of an ink sample on the line. You can use capillary tube or toothpick to transfer the sample. If you overload sample, you might not separate the components effectively.
4. Add distilled water to the 500 mL beaker so that the end of the chromatography paper will be in the water. (as shown in the diagram.)

Deleted: p

Deleted: c

Deleted: We will

Deleted: get

Deleted: A pencil

Deleted: is drawn

Deleted: A

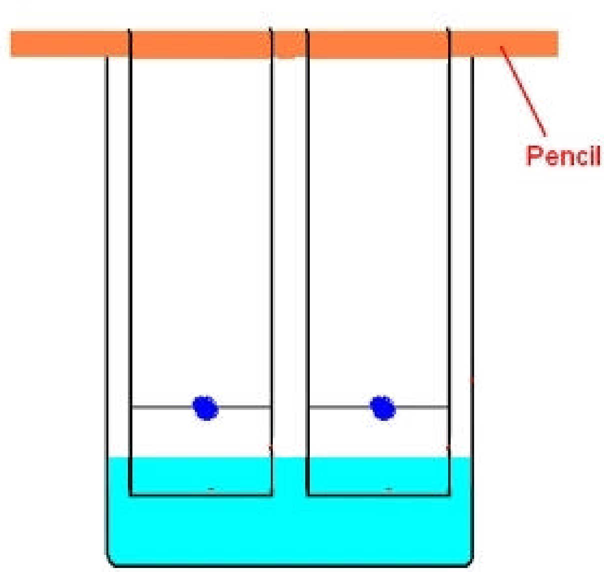
Deleted: is placed on each paper

Deleted: h

Formatted: Not Highlight

Deleted: If the sample is too dilute, you can spot the sample several times in one place.¶

Formatted: Highlight



5. Place a pencil across the top of the glass and tape the chromatography paper. Suspend the paper inside the 500 mL beaker.

6. When the solvent front gets close to the top of the paper, remove the chromatography paper from the beaker.

7. Mark the solvent front with pencil and dry the paper.

8. Write down your team code onthe top of the chromatography paper and tape on the answer sheet.

II-1. Which sample(s) have the yellow color component? (1.5 points)

(A) sample #1 only

(B) sample #2 only

(C) sample #1 and sample #2

(D) none

II-2. Which sample(s) have the red color component? (1.5 points)

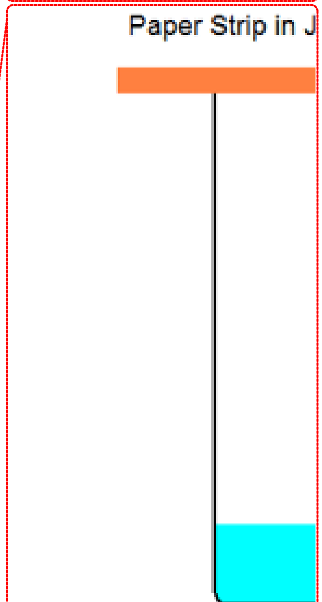
(A) sample #1 only

(B) sample #2 only

(C) sample #1 and sample #2

(D) none of them

Deleted: Place a pencil across the top of the glass and tape the chromatography paper. Suspend the paper inside the 500 mL beaker. ¶
5. Fill the beaker with distilled water until the end of the chromatography paper just touching the solvent. ¶



Deleted:

Formatted: Font: (Default) Times New Roman, (Asian) ? ? ? ? , 12 pt, Font color: Black

Deleted: 6. The mixture will travel slowly up the paper. ¶

Deleted: 7

Deleted: 8

Deleted: 9

Deleted: pigments

Deleted: pigments

II-3. How many color component(s) are (is) present in sample #2? Choose the letter for the color(s) listed. (1 point)

(A) Red (B) Yellow (C) Blue (D) Orange

(E) Green (F) Purple (G) Black

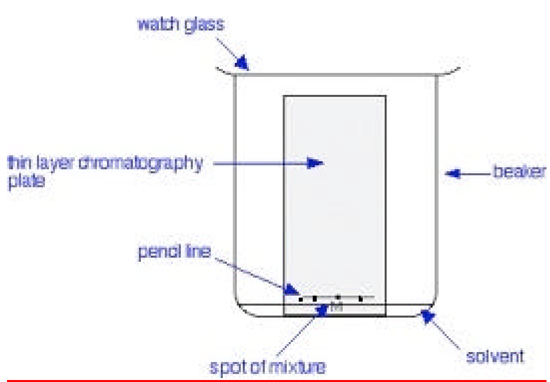
Question II-2 Thin Layer Chromatography

Thin layer chromatography (TLC) is done using a thin, uniform layer of silica gel or alumina coated onto a piece of glass. The silica gel is the stationary phase. The mobile phase is a suitable liquid solvent or mixture of solvents.

Two 5.0 x 10 cm TLC plates (white silica on glass substrate) are provided. **Be careful not to touch the silica surface with your finger.**

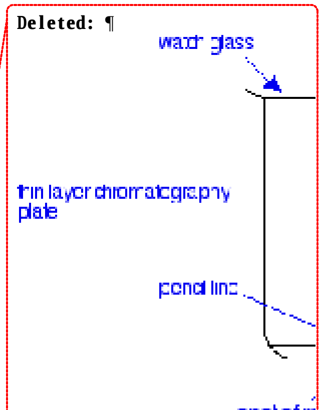
1. Use a pencil to draw a line near the bottom of the TLC plate and place a very small drop of the sample on it. Place four spots (sample #1-#4 from left to right) on the first TLC plate and three spots (sample #5 - #6 and one for the marker pen provided from left to right) on the second TLC plate.

2. When the sample spots are dry, stand the plate in a shallow layer of ethanol in a covered 300 mL beaker. (If the spot does not dry well, you can use a hair dryer. Hair driers are available upon your request.)



3. As the solvent slowly travels up the plate, the different components of the sample mixture travel at different rates and the mixture is separated into different colored spots.

Deleted: ¶
Deleted: Describe the color in English and Rf value of the each pigment
Formatted: Indent: First line: 0", Left 2.7 ch
Deleted: pigment
Formatted: Not Highlight
Deleted: (1 point)
Deleted: a
Deleted: The stationary phase for thin layer chromatography also often contains a substance which fluoresces in UV light.
Deleted: 1.
Formatted: Indent: First line: 0.3"
Formatted: Not Highlight
Deleted: 2
Formatted: Not Highlight
Deleted: A pencil line is drawn
Deleted: transfer
Deleted: a
Deleted: is placed
Formatted: Not Highlight
Formatted: Not Highlight
Deleted: 3
Formatted: Not Highlight
Deleted: ¶



Formatted: Indent: Left: 0.28"
Formatted: Bullets and Numbering

When the solvent front gets close to the top of the plate, remove the TLC plate from the beaker.

4. Mark the solvent front with pencil.

5. Write down your team code on the top of the TLC plate with a pencil.

II-4. Based on the TLC data, group the samples #1 to #6. (0.5 point for each correct answer)

II-5. Refer to the TLC chromatogram of the ink sample #1. How many color component(s) is(are) present in sample #1? Choose the letter for the color(s) listed, and determine the Rf value(s) of each color component. (2.5 points)

(A) Red (B) Yellow (C) Blue (D) Orange

(E) Green (F) Purple (G) Black

II-6. Refer to the TLC chromatogram of the black ink of a marker pen. How many color component(s) is(are) present in the ink? Choose the letter for the color(s) listed, and determine the Rf value(s) of each color component. (2.5 points)

(A) Red (B) Yellow (C) Blue (D) Orange

(E) Green (F) Purple (G) Black

II-7. The R_f of a spot contains information regarding the attraction of the substance being chromatographed to the plate and the eluting solution. Which combination of the color component and TLC stationary phase would have the largest R_f if a polar solvent(mobile phase) is employed? (1 point)

(A) polar color component on polar TLC adsorbant (stationary phase)

(B) non-polar color component on polar TLC adsorbant (stationary phase)

(C) polar color component on non-polar TLC adsorbant (stationary phase)

(D) non-polar color component on non-polar TLC adsorbant (stationary phase)

6. Once you have finished the TLC experiment, raise your hand and assistants will collect the TLC plates.

- Deleted: paper
- Formatted: Bullets and Numbering
- Deleted: chromatography paper
- Deleted: and tape on the answer sheet.
- Deleted: Once you finished the TLC experiment, raise your hand
- Formatted: Not Highlight
- Deleted: Group the ink sample #1 - #6 into either 3 or 4 different inks using paper chromatography and TLC data
- Deleted: sample
- Deleted: pigment
- Deleted: are(
- Deleted:)
- Deleted: Describe the color in English and Rf value of the each pigment.
- Deleted: (2.5 points)
- Deleted: pigment
- Deleted: are(
- Deleted:)
- Deleted: Describe the color in English and Rf value of the each pigment. (2.5 points)
- Deleted: aper
- Deleted: pigment
- Deleted: are
- Deleted: pigment
- Deleted: pigment
- Deleted: pigment
- Deleted: pigment
- Formatted: Indent: Left: 0"
- Deleted: ¶

Experiment III: Eye

Eyes are organs that detect light, and send signals along the optic nerve to the visual and other areas of the brain. There are many types of eyes, but an example of a very advanced type is the human eye which is similar to a camera. Therefore, we often refer to this type of eye as a 'camera type eye'. Camera type eyes can easily be seen in vertebrates and cephalopods. In fish and cephalopods, the lens of the eye moves back and forth to produce an image on the retina. In this experiment, we will use a system which resembles the squid's eye by focusing and producing an image through moving the lens back and forth.

The relation between image and object (*i-o* relation)

Experimental procedure

1) Put the light source on the optical rail on one side.
2) Attach one of the screens to the light source. (This will reduce the light to make a clearer image of the object)
3) Put the object on the rail close to the light source.
4) Place the convex lens in the middle of the rail.
5) Put the additional screen on the rail as far away as possible from the object.
6) Move the lens back and forth to make a clearer image of the object on the screen. You will find two lens positions where a sharp image is formed. One is for an enlarged image and the other for a reduced one. **For both of these positions, carry out the following steps.**
   a. Record the distance between the object and the lens (*o*).
   b. Calculate and record the reciprocal value of *o* (1/*o*).
   c. Record the distance between the lens and the image (*i*).
   d. Calculate and record the reciprocal value of *i* (1/*i*).
   e. Record the size of the object (y_0).
   f. Record the size of the image (y_i).
   g. Calculate and record the magnification of the image ($M=y_i/y_o$)
7) **III-1) Move the screen towards the object, and repeat procedure 6). Collect data for at least 5 different distances between the object and the screen including the initial distance. (6 points)**
8) **III-2) Find the value of *o* and the value of *i* when the magnification is 1. (1.0 point)**

Questions:

III-3) Plot the graph of 1/*i* versus 1/*o*. (3 points)

Draw the line of best fit. (0.5 point)

III-4) Estimate the slope of the line and find the intercept on the 1/ *i* -axis. (1.0 point)

III-5) The focal length of the convex lens is the reciprocal of the intercept. Determine the focal length of the lens used in this experiment. (0.5 point)

Human eye

However, in the case of the human eye, the curvature of the lens changes to focus the image onto the retina. Variation in the focal length of the flexible lens is called accommodation.

Accommodation enables the human eye to form a sharp image of the object on the retina at a range of distances from the near point to the far point. A young adult with good vision has a near

Deleted: Page Break [1]
Formatted [2]
Formatted [3]
Formatted [4]
Formatted [5]
Formatted [6]
Deleted: s
Formatted: Font: Italic
Formatted: Font: Italic
Deleted: the
Deleted:
Deleted: screen
Deleted: (type A)
Deleted: (S)
Deleted: away from the object
Deleted: (S)
Formatted: Font: Bold, Underline
Deleted: Repeat 1-5 as you [7]
Deleted: Record
Deleted: Record
Deleted: Record
Deleted: Get
Deleted: 5
Deleted: the distance of the [8]
Deleted: the distance of the [9]
Deleted:)
Deleted: re
Formatted [10]
Formatted: Indent: Left 3.6 ch
Deleted: ted straight line [11]
Deleted:
Deleted: s
Deleted: c
Deleted: point
Deleted: f
Formatted [12]
Formatted: Indent: Left 3.6 ch
Deleted: s
Deleted: c
Deleted: point value
Deleted: thickness
Deleted: make a clearer image
Deleted: an

point of 25 cm and a far point of infinity. The human eye is more or less spherical in shape, with an average diameter of 25 mm.

Deleted: or less
Deleted: H
Deleted: close to a

III-6) Using the data for the young adult and your experimental results, determine the focal length of the lens of the human eye at near point. (0.5 point)

III-7) Determine the focal length of the lens of the human eye at far point. (0.5 point)

Deleted: **the *i-o* relationship you derived from**
Deleted: **find**
Deleted: **human**
Deleted: **Find**
Deleted: **human**

Page 12: [1] Deleted **ijso** **12/12/2008 8:28:00 PM**

Page Break

Part

Page 12: [2] Formatted **ijso** **12/12/2008 8:28:00 PM**

Font: Times New Roman, 16 pt, Bold

Page 12: [3] Formatted **ijso** **12/12/2008 8:28:00 PM**

Font: Times New Roman, 16 pt, Bold

Page 12: [4] Formatted **ijso** **12/12/2008 8:28:00 PM**

Font: Times New Roman, 16 pt, Bold

Page 12: [5] Formatted **ijso** **12/12/2008 9:15:00 PM**

Indent: Left: 0", First line: 4.5 ch

Page 12: [6] Formatted **ijso** **12/12/2008 8:28:00 PM**

Font: Times New Roman, 16 pt, Bold

Page 12: [7] Deleted **ijso** **12/12/2008 1:25:00 PM**

Repeat 1-5 as you find a sharp image.

Page 12: [8] Deleted **ijso** **12/12/2008 5:13:00 PM**

the distance of the object (*o*)

Page 12: [9] Deleted **ijso** **12/12/2008 5:13:00 PM**

the distance of the image (

Page 12: [10] Formatted **ijso** **12/12/2008 8:29:00 PM**

Indent: First line: 0", Left 3.6 ch

Page 12: [11] Deleted **ijso** **12/12/2008 4:55:00 PM**

ted straight line which includes the data points

Page 12: [12] Formatted **ijso** **12/12/2008 8:29:00 PM**

Indent: First line: 0", Left 3.6 ch