STUDYING STEM

SCIENCE TECH ENGINEERING MATHS

at the ZOO

This pack is designed to provide teachers with information, activities, and worksheets to help you lead a trip to Colchester Zoo focusing on the STEM subjects.

COLCHESTER ZOO
Action for the Wild

BRITISH SCIENCE ASSOCIATION

How to use these Activities

This STEM pack was designed to help you plan your trip to Colchester Zoo focusing on the STEM subjects (Science, Technology, Engineering, and Maths). This pack contains a variety of activities and worksheets focusing on a range of STEM subjects. The worksheets encourage the use of different scientific skills, with specific emphasis on real world problem solving.

All the activity worksheets are discrete, and teachers can pick and print only the pages they wish their students to complete. Omitting any specific page will not impact on the others.

Many of these activities and worksheets can be completed anywhere around the zoo. Some of them require visiting a specific area/animal. These worksheets include details of where to go in the instructions. There is also a map at the start of the pack (p.1) which labels these key areas. Activities without a specific location on the map can be completed anywhere or in a variety of locations (e.g. at any animal enclosure rather than a specific enclosure).

This pack contains activities for a wide range of ages and learning outcomes. Most of the activities are best suited for upper KS2 or KS3 students but can be adapted to suit higher or lower abilities as well. Many of these activities require prior knowledge of a topic and work best if students are already familiar with the material. For example, a KS2 class learning about water quality could complete the 'Water Turbidity' activity, but a KS3 class who hasn't study water quality might struggle with the same activity. Each activity is labelled in the top right corner with the specific STEM subject or field of study it relates to. The table of contents on the next page also lists the main STEM topic each activity relates to. When selecting activities to use with your students, please select appropriate activities relating to concepts the students are familiar with. Some of the activities can be completed in the classroom after the trip, but require collection of initial data at Colchester Zoo.

Many of the activities and worksheets included in this pack do not include answer sheets. This is because the answers are based on student observation (so there is not a specific numerical or written answer). A few of the physics based worksheets do include a teacher answer sheet with the answers in red. These pages are clearly labelled at the top and are on the page immediately after the student page.

If you would like some guidance for any of the activity answers, or examples of calculations/worksheets completed by other groups, please contact the education department at education@colchesterzoo.org

Contents

ACTIVITIES TO COMPLETE AT THE ZOO

COLCHESTER ZOO
Action for the Wild

Activity locations around Colchester Zoo

(see key on next page)

Download a more detailed map from our website:
www.colchesterzoo.org

Activity locations around Colchester Zoo:

(see map on previous page)

1. Orangutan Forest

Needed for Water Turbidity activity on page 12

2. Giraffe House

Needed for Water Turbidity activity on page 12

3. Koi Niwa

Needed for Water Chemistry activity on page 15

4. Sea Lion Tunnel

Needed for Underwater Tunnel activity on page 18

5. Lemur Enclosure

Needed for Enclosure Design - Jump Distance activity on page 21

6. Elephant House

Needed for Enclosure Design - Hydraulic Forces activity on page 23

7. Chimp House

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8. Sun Bear Enclosure

Needed for Enclosure Design - Slope Erosion activity on page 27

9. Dragons of Komodo

Needed for Enclosure Design - Green Technology activity on page 29

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11. Remi Brown Play Area

Needed for Engineering - Play Area Design activity on page 31

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Needed for Cheetahs and Bottlenecks activity on page 35

13. Nature Reserve

Needed for Native Wildlife Habitat Assessment activity on page 36

14. Train Station

Needed for Train - Designing a Vehicle & Functionality activities on page 37 and 38

Please note that animals on display may change

Pre-Trip Classroom Ideas:

These are ideas to get teachers thinking about how to introduce the concept of STEM and how it relates to zoos. Use these ideas as a starting point.

1. Research the zoo using their website. Compare their website with other zoos. What did the students like about the website? What features showed poor design? As an extension, have students design their own zoo website.

2. If focusing on engineering of specific animal enclosures, have students select a specific animal prior to the trip and research what its needs are. During the trip, students can compare their data to the real world assessment of the enclosures.

3. Discuss the term 'endangered', have pupils research endangered animals and discover some of the technology involved in saving them (e.g. Frozen Ark, crowd-sourcing camera-trap identification, cloning - e.g. African Wildcat)

4. Brainstorm different ways that zookeepers might need to use maths and science skills in their jobs.

5. Complete a daily audit to determine how much the students use STEM in their everyday life - discuss what would be the same or different if their daily life involved worked at a zoo.

6. Learn about biomimicry and bio-imitation. Research different fields that use technologies based on nature (e.g. medicine, robotics, engineering, etc.)

7. Before the trip have students choose a specific animal and have them create a list of questions to ask themselves whilst at the zoo.

8. Research water filtration and conduct experiments on different filtration mediums. At the zoo, look at the large filtration system for the fish tanks. Compare these real systems to your tests.

At the Zoo Ideas:

These are ideas to help your class focus on STEM during their trip to the zoo. Use these ideas as a starting point with or without the pre-made activities and worksheets on the following pages.

1. Take photos of the animals and the zoo. When you get back to school make a digital scrapbook of your trip.

2. Attend the feeds, shows or talks and have your students take notes. Often the keepers are available after to ask questions if you want to learn more.

3. Have pupils keep track of how many of each type (e.g. monkey, mammal, bird, big animal, small animal, etc.) of animal they see. Graph these results back at school. Which type is the most common at the zoo. Why do they think the zoo has the most of that type of animal?

4. Create your own checklists of different types of STEM, have students mark off which topics/subjects they see in use at the zoo - STEM is more than just working in labs or completing calculations!

5. Take notes of the design and function of animal enclosures around the zoo. When you get back to school create model animal enclosures that could fulfil the same engineering requirements (e.g. strength, moving water, electrical fences, etc.) as the real ones.

6. Download and use the Colchester Zoo app as you navigate around the zoo.

7. Gather information about animals at the zoo. Back at school afterwards, create simple light up circuit boards to create question guessing/matching based on the information the students gathered.

8. Track your time during your visit (e.g. 10:00-10:10 entering the zoo, 10:10-11:00 - looking at animals, 11:00-11:20 - snack). At the end of the day create graphs showing how much of your time was spent seeing the animals. As an extension, have the students try to develop a plan for future trips that would enable to use their time in different ways.

Scientific Observations

At the zoo I went to the ______________________________

(fill in which animal you observed)

Record your observations of the animal in the box below.
Draw or write what you saw. Make sure to label any drawings.

Thinking about my animal and my observations….
I wonder: ______________________________

I learned: ______________________________

I have more questions about what I learned. My questions are:

Thinking Scientifically - Questioning

Animal to investigate:

Question

What questions do you have about your chosen animal?

E.g. I wonder where fennec foxes live?

Evidence

What information can you gather through observations that will answer your questions?

E.g. The fennec fox enclosure is sandy like a desert.

Claim

Make a statement based on your evidence to answer your questions.

E.g. I think fennec foxes live someplace hot.

Reasoning

Explain how your evidence supports your claim statement.

E.g. Fennec foxes live someplace hot, because their enclosure is designed to mimic a desert.

Thinking Scientifically - Developing a Hypothesis

Animal to investigate:

Hypothesis

What 'educated guess' can you make about the animals and/or its enclosure?

E.g. fennec foxes live in hot places

Evidence

Observe the animal and the enclosure, read the signs nearby and look for other information. Write all these facts below.

E.g. the fennec fox enclosure is sandy and has dry desert plants.

Reasoning

How does the evidence you collected relate to your hypothesis?

E.g. Evidence shows that fennec foxes live in deserts because their enclosure is designed like a desert.

Result

Analyses your hypothesis based on your reasoning, what is correct?

E.g. My hypothesis was correct, fennec foxes do live in hot places, specifically they live in deserts.

Dietary Vitamins and Supplements

Just like humans, many primates (monkeys and apes) can get arthritis as they age. In order to prevent this these animals are given specific vitamin and mineral supplements to slow the onset, or prevent arthritis developing. The amount of these supplements required in their diet is different depending on the activity level of the animals. More active animals require higher dosages, because of the increased movement on their joints.

Using the map, find the five different primate species listed below at the zoo. Observe the group of animals for 5 minutes. Using the data sheet, at each minute mark (at 1min, 2min, etc.), place check marks for all the behavior observed at that time. At the end of five minutes tally up all the behaviors in each category (active or inactive). Using the total behaviors, calculate the percentage of the animals' behavior which is active. Use this to categorises the animals with the following information.

Percent of Behaviour	Activity Level	Calcium Supplement/day*	Vit D Supplement/day*
>75% Active	Extremely Active Species	1,000mg	1mg
<75% but >50% Active	Active Species	750mg	0.8mg
<50% but >25% Active	Inactive Species	500mg	0.8mg
<25% Active	Extremely Inactive Species	300mg	0.7mg

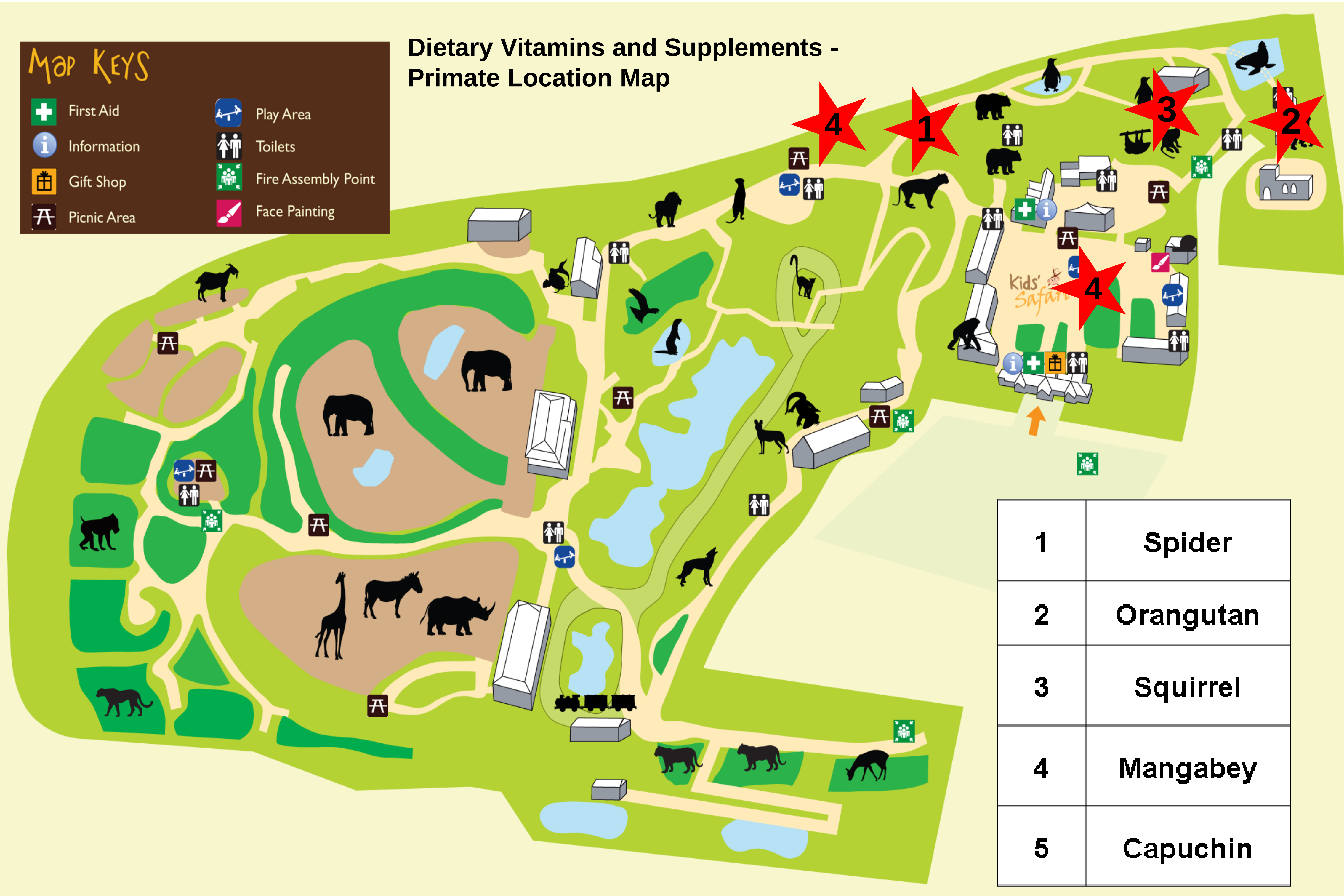
*note: these supplements are calculated for large, approximately human size primates. Medium sized primates should have half these amounts. Small sized primates should have one quarter of these amounts.

Complete the below table based on the observations you recorded on the data sheet and the above information.

(Remember to include size in your supplement amount calculations.)

Animal	Primate Size	Activity Level (from your observations)	Calcium Supplement/day* (from the table above)	Vit D Supplement/day* (from the table above)
Spider Monkey	Medium			
Orangutan	Large			
Squirrel Monkey	Small			
Mangabey Monkey	Medium			
Capuchin Monkey	Small			

Dietary Vitamins and Supplements - Primate Location Map



1	Spider
2	Orangutan
3	Squirrel
4	Mangabey
5	Capuchin

Dietary Vitamins and Supplements - DATA SHEET

Use this sheet to collect data to complete calculations required to calculate arthritis dietary supplements required for various primates.

Observe the group of animals for 5 minutes. At each minute mark (at 1min, 2min, etc.), place tally marks for all the behavior observed at that time (you can record more than one behaviour if the animal is doing multiple things at the same time). At the end of five minutes tally up all the behaviors in each category. **'Moving' and 'Eating/Drinking' are active behaviours**. **'Sleeping' and 'Lying Down/Sitting' are inactive behaviours**.

Using the total behaviors, calculate the percentage of the animals' behavior which is active.

The Mandrill monkey has been completed for you as an example.

Species: Mandrill Monkey

Moving	Eating/Drinking	Sleeping	Lying Down/Sitting
卌 ||	|||		||||

Total Active behaviours: 10 Total Inactive behaviours: 4

Percent of behaviours which are active: (10 / (10+4))x 100 = 71.4%

Species: Spider Monkey

Moving	Eating/Drinking	Sleeping	Lying Down/Sitting

Total Active behaviours:______________ Total Inactive behaviours:____________

Percent of behaviours which are active:____

Species: Orangutan

Moving	Eating/Drinking	Sleeping	Lying Down/Sitting

Total Active behaviours:______________ Total Inactive behaviours:____________

Percent of behaviours which are active:____

Species: Squirrel Monkey

Moving	Eating/Drinking	Sleeping	Lying Down/Sitting

Total Active behaviours:______________ Total Inactive behaviours:____________

Percent of behaviours which are active:____

Species: Mangabey Monkey

Moving	Eating/Drinking	Sleeping	Lying Down

Total Active behaviours:______________ Total Inactive behaviours:____________

Percent of behaviours which are active:____

Species: Capuchin Monkey

Moving	Eating/Drinking	Sleeping	Lying Down

Total Active behaviours:______________ Total Inactive behaviours:____________

Percent of behaviours which are active:____

Animal Diets - What do they eat at the zoo?

Animals eat different things. Herbivores are animals that eat plants. Carnivores are animals that eat meat. Omnivores are animals that eat plants and meat.

While at Colchester Zoo, find an animal which is eating food/has food visible in it's enclosure. On signs at the enclosure, find out what the animal usually eats in the wild. Answer the questions. Repeat for a different animal with a different diet (e.g. if you selected a herbivore first, repeat for an omnivore or carnivore).

ANIMAL 1

What animal are you observing? ____________________________________

Is it a herbivore, omnivore, or carnivore? ______________________________

What food does the animal have? ____

____

____

What food does the sign say this animal would eat in the wild?_________________________

____

____

Was the animal eating the same thing it would in the wild? If not, why do you think it is fed something different? ____

____

____

ANIMAL 2

What animal are you observing? ____________________________________

Is it a herbivore, omnivore, or carnivore? ______________________________

What food does the animal have? ____

____

____

What food does the sign say this animal would eat in the wild?_________________________

____

____

Was the animal eating the same thing it would in the wild? If not, why do you think it is fed something different? ____

____

____

Water Turbidity - Teacher Information
Is there enough light for the coral?

Physics (light), marine science, hydrology

Although coral is an animal, many corals also have the ability to photosynthesis (like plants, to produce energy from sunlight) because of their special sensitive cells (zooxanthellae cells).
Clear water allows light to pass through it very easily. Water with a high turbidity (cloudiness or haziness caused by very small particles floating in the water) does not allow light to pass through.

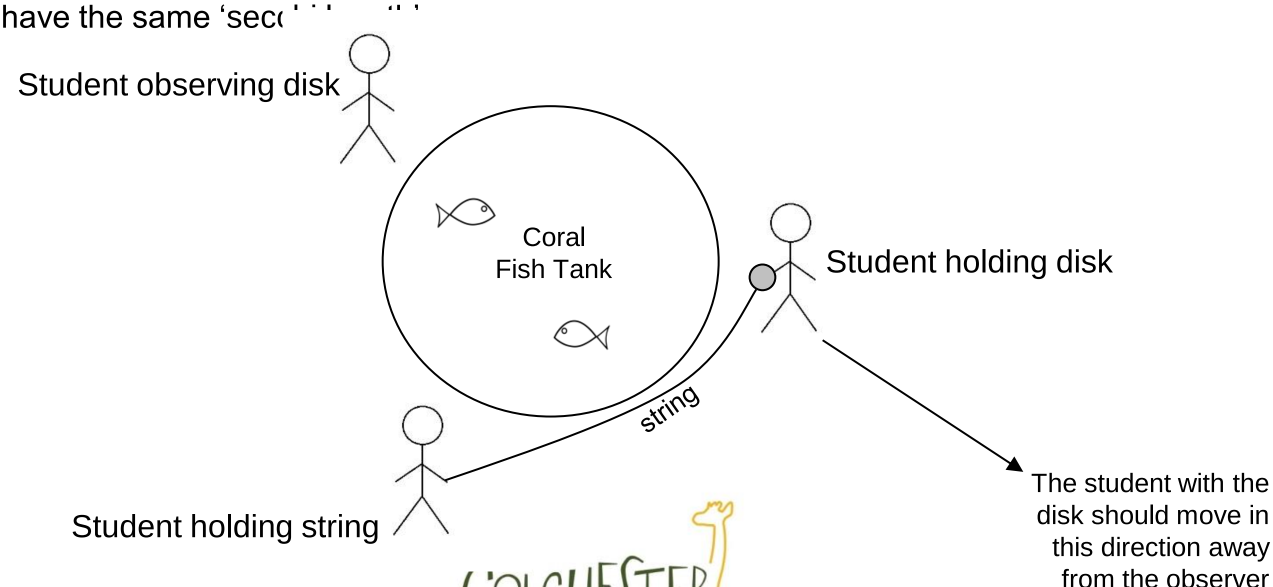
Scientists use a tool called a secchi disk to measure water turbidity. In marine water, these disks are usually pure white and 30cm across, in fresh water, these disks are usually black and white and measure 20cm across. The disk is attached to a string and lowered into the water. The disk is lowered until it can’t be seen and the depth (how much string has been let out) is recorded as the secchi depth.

Your task is to measure the water turbidity in the zoo’s coral tanks. Coral needs water with a lower turbidity, in order to allow light to reach it. Ideally, the modified ‘secchi length’ should be at least twice as long as the height of the aquarium (since the lights for the aquarium are located near the top).

Print the modified ‘secchi length’ disk on A4 paper. Cut the disk out and attach a string in the middle. Have one student stand on the far side of the circular coral tank (they are the observer). Have another student hold the end of the string. Have a third student stand in the opposite corner of the tank and look at the disk (see diagram). The student moving the disk should move backwards, trying to keep as much of the tank in between then and the observer as possible. Because the tank is curved, the string might curve and may move along the edge of the tank. For the purposes of this experiment, that is fine. Ensure the observer does not have something physically obstructing their view (e.g. a wall of coral) - they are just looking through the water, not trying to have x-ray vision.

The student moving the disk should move backwards (away from the observer) until the observer can not visually see the difference between the grey and white portions of the modified secchi disk. Measure the length of string that was let out. This is the ‘secchi length’ for the tank. Repeat the experiment, rotating positions so that all students get a chance to observe. Average these three measurements to get a more accurate ‘secchi length’.

Students can record their findings on the data sheet to determine if the turbidity is great enough to affect the quality of light reaching the coral.
Students can repeat this experiment at the second free-standing coral tank to determine if both tanks have the same ‘sec

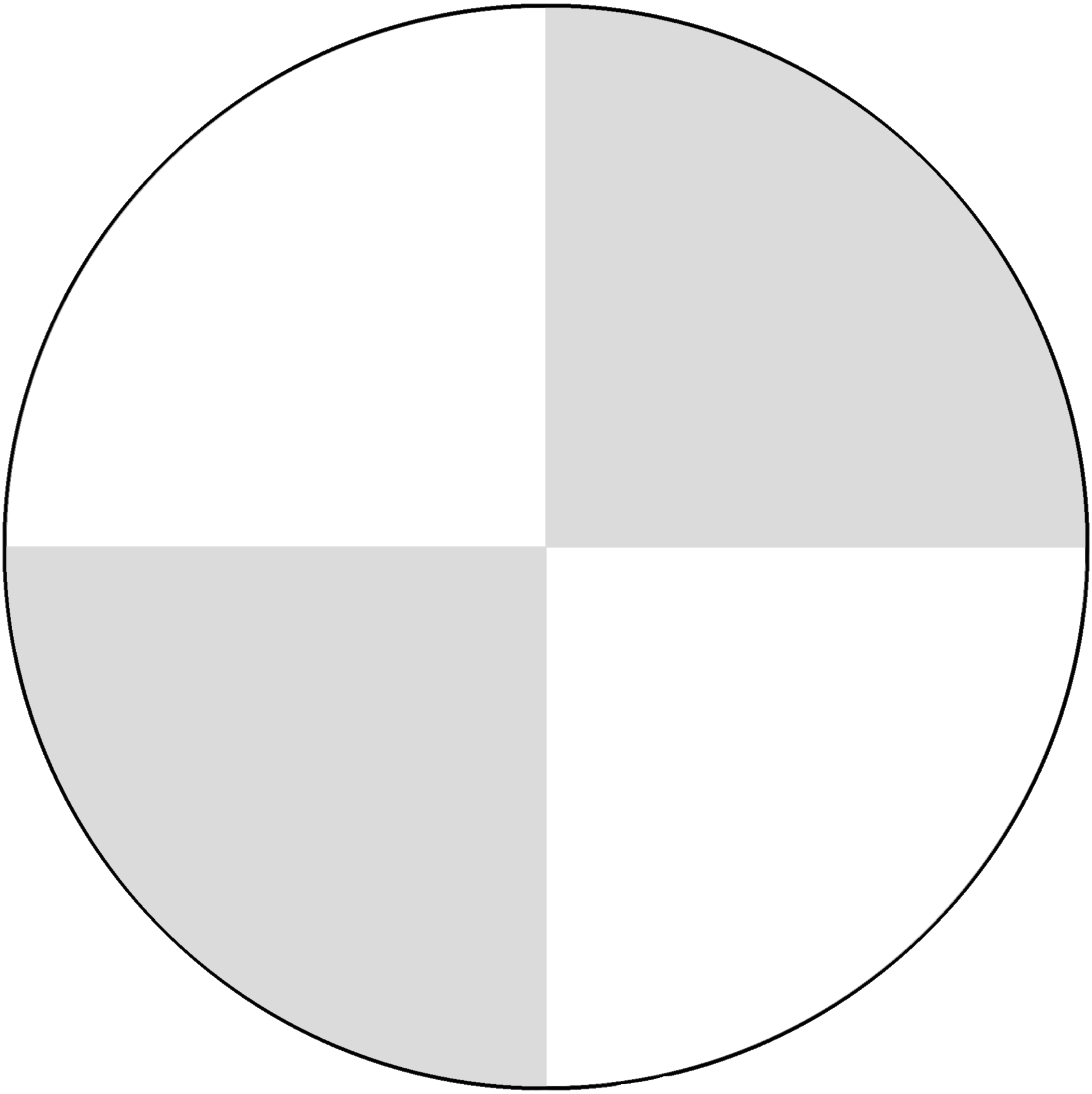


COLCHESTER ZOO
Action for the Wild

Water Turbidity - SECCHI DISK

Secchi disks are used to measure water turbidity. They are usually dropped down into the water. This secchi disk has been modified to be used horizontally, looking through a free standing aquarium.

Print this disk on A4 paper (so it remains the same size). Attach a string to the centre of the disk.(Optional) Glue the disk onto card to make it stiffer and more durable.



Water Turbidity - DATA SHEET

Coral Tank in Orangutan Forest

Estimated height of the tank:____

Only include the height of the tank which contains water

Do not include the base/top of the tank (since the light doesn't need to pass through these)

Observer 1 Name:____

Observer 1: Length of string where the secchi disk colours look the same: _______________

Observer 2 Name:____

Observer 2: Length of string where the secchi disk colours look the same: _______________

Observer 3 Name:____

Observer 3: Length of string where the secchi disk colours look the same: _______________

Average 'secchi length' from the above three measurements: ________________________

Is the average 'secchi length' greater than two times the estimated height of the tank? _______

If yes, this means the tank turbidity is very low and the light quality is high.

If not longer than two times, but still longer than the height, the turbidity is acceptable and the light quality is still quite high.

If the secchi length is less than the estimated height of the tank, the turbidity is very high, and the light quality is very low - so low that it might cause problems for the growing coral.

Do you think the coral is getting enough light? Explain your answer: ____________________

____

____

____

Coral Tank in the Giraffe House

Estimated height of the tank:____

Only include the height of the tank which contains water

Do not include the base/top of the tank (since the light doesn't need to pass through these)

Observer 1 Name:____

Observer 1: Length of string where the secchi disk colours look the same: _______________

Observer 2 Name:____

Observer 2: Length of string where the secchi disk colours look the same: _______________

Observer 3 Name:____

Observer 3: Length of string where the secchi disk colours look the same: _______________

Average 'secchi length' from the above three measurements: ________________________

Is the average 'secchi length' greater than two times the estimated height of the tank? _______

If yes, this means the tank turbidity is very low and the light quality is high.

If not longer than two times, but still longer than the height, the turbidity is acceptable and the light quality is still quite high.

If the secchi length is less than the estimated height of the tank, the turbidity is very high, and the light quality is very low - so low that it might cause problems for the growing coral.

Do you think the coral is getting enough light? Explain your answer: ____________________

____

____

____

Aquarium Chemistry - Water Filtration

Aquariums need clean water, because in dirty water fish are unable to get oxygen from the water and cannot survive. The filter system remove the waste produced by fish: nitrites, nitrates, and ammonia.

There are three main methods of water filtration: physical, biological, and chemical.

Visit the koi fish (near the farm animals, between elephants and lorikeets). There are two very large fish tanks with very large visible filtration systems.

1) After reading the signage, and observing the pools, draw a diagram of the aquariums and filter system on the back of this page. Make sure to label the directional flow of water to show how water moves through the system.

2) The first filter water passes through is the vortex, which removes heavy solid material. This is a physical filter. Why do you think it is important to physically remove the larger pieces of solid material from the water before moving onto other types of filtration? ______________________

3) When the koi fish were first placed in the tank, there were problems with water quality because the biological filters were new and not yet established. Why do biological filters need time? ____

4) Now that the biological filters are established, the tank is very stable and rarely has problems with nitrites or ammonia. If more fish were added to the tanks with no other changes made, what would happen? ______________________

5) The final stage the water passes through is the UV steralisation system. In your own words, explain why you think the UV steralisation system is a physical or chemical filtration system, OR if you think it is not a filter. Provide reasons to support your argument: ____________________

Aquarium Engineering - Teacher Information

Water is a difficult material to contain, which is why retaining large amounts of water, with the use of structures like dams, is so complex.
Aquariums use the exact same science as dams, but on a (usually) much smaller scale.
Aquariums also need to deal with the added complexities of being made out of see-through material. Glass and Perspex are not as structurally strong as materials such as concrete, so this makes the project more challenging.
The zoo has many different types of aquariums in all sorts of sizes and shapes. Use a trip to the zoo to research first hand the variety of aquariums and take detailed notes about their design, shape, and most importantly—the thickness of their glass and/or Perspex.

Use the data collection sheet on the next page to collect information about the aquariums the students see at the zoo. Print out multiple sheets to have students collect information from a range of aquariums, or just one per student and have them collect data about the aquarium they think is best.

For simplicity, we recommend the students only collect information from the fish aquariums, and not the penguin tanks nor the sea lion tank. Due to their size, and other specific characteristics about their animals, these tanks have many added complexities.

Back at school, have the students work in groups to analyse their data and design their own aquariums.

Working in groups, have students share their designs with each other. They can combine elements of their designs to create one test project. Building in large plastic trays (plant trays, plastic storage boxes, etc.) have students build their aquarium out of material found in the classroom. Suggested building materials include: plasticine, play-dough, plastic food wrap, cardboard, pipe cleaners, takeaway food storage containers (cut into small squares, not as an entire box), clear plastic food wrap, clear plastic bags, lego or other construction blocks, sand, gravel, toy fish, plastic plants, etc.

After the students construct their aquariums, pour water into them to test if they hold water. After one water test, allow the students time to revise and update their designs based on their observations. Re-test the new and improved designs.

As an entire class, analyse the results and discuss which parts of each design they thought were best, and which parts could be improved.
Discuss as a group which shapes seemed to work best (rectangular aquariums, column aquariums, etc.) and why they think this was.

Remember to think about: the needs of the fish/other animals in the aquarium (it doesn't just need to hold water, but also be a good habitat) - does adding gravel to the bottom make it harder to hold water? Does adding plastic plants to the water change how the water behaves?

Remember to think about: the needs of the visitors viewing the aquarium. Can they see the animals inside? Are there bits that block their view? Can they walk all around the aquarium or is it built into a wall or corner location?

Describe the aquarium shape:
(rectangular, column, etc.)

____

____

____

Estimated height:_______

Estimated width:________
(or circumference if relevant)

Estimated length:_______

Other notes:

____

____

____

____

____

____

____

Sketch the Aquarium

Remember to include it's shape, and any interior features such as rocks, pipes, etc.

Estimated width of aquarium wall:________________________________

Is the aquarium wall the same thickness on all walls? ____________

Is the aquarium wall the same thickness near the bottom as at the top? (does the wall taper) ____

Is the wall straight, or does it curve? ____________________________

Does the wall have any buttressing supports near the base? ______

____

If the walls have supports, where are they? (at the corners, in the middle, etc.) ____

How transparent is the aquarium wall? ________________________

____

Is the aquarium free standing? ________________________________

Are all the walls/sides transparent? ___________________________

____

Underwater Tunnel

Visit the Sea Lion underwater viewing area and examine the tunnel and answer these questions. Glass is not very suitable for windows this large, as it is very brittle so it would need to be very thick to stop it shattering. When glass is this thick, it causes a lot of reflection and bending of light which means it is very difficult to look through and actually see the sea lions. Instead, polymethylmethacrylate (also known by trade names as Perspex and Plexiglass) is used because it is half as dense as glass and twice as strong. Is also has a low level of reflection. This allows the 'window' portion of the tunnel to be thinner (than glass) while still providing a clear view.

How do you think the see-through part of the tunnel was built - was it installed in place, built elsewhere and move, etc.? Why do you think this? (hint: can you see any connections or joints, what could those mean?)____

The tunnel was built with the bottom wall separated from the top, curving section. The bottom is not made of the same clear curving Perspex as the top (it is solid cement covered in wood on the inside). Why do you think the bottom edge isn't made of Perspex? What evidence supports your guess?____

Estimate the length of the tunnel by walking along it and counting your footsteps. How long is the tunnel? ____

Do you think the tunnel could be longer, without changing the structure of it? Or is this the maximum length that the tunnel could be? Why do you think this?

Go to the above water viewing area of the sea lion pool. What shape is the sea lion pool? Draw it below:

Draw where you guess the tunnel crosses through the pool in your above picture.
Does the sea lion tunnel cross directly through the middle of the pool, or does it cross through at an angle? Why do you think this is? ____

Bio-inspired Robotic Design

Bio-inspiration involves studying nature and looking for mechanisms or functions that can be used to solve real-world engineering problems. There are many examples of bio-inspiration across engineering fields and it is a rapidly growing segment of soft robotics. Rather than focusing on the entire nature system (e.g. the whole animal), bio-inspiration robotics usually focus on one specific part, for example, biosensors (e.g. mimicking eyes), bio-actuators (e.g. muscles), or locomotion systems (e.g. how an animal moves).

Your task is to design a robot which mimics the movement of a real animal. Choose an animal at Colchester Zoo that you can see moving (don't choose an animal that is asleep or not moving), and answer the following questions.

What animal have you selected: ____

Sketch the animal on the back of this worksheet - it doesn't need to look pretty, you are just trying to record details such as how many legs it has, does it have a tail, does it have a long neck, etc. Label any relevant features.

What speed does the animal move at? (is it slow, fast, etc.) ______________________________

____

____

What would a robot that moves like this animal be useful for, and why? (e.g. a search and rescue robot, helping elderly people in their homes, spy robot, military defence, speedy parcel delivery, etc.)

____

____

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____

____

What part about the animal do you think is important to how it moves? (e.g. its tail might help it balance, its claws might give it good grip, its extra long feathers help it fly, etc.) Be as specific as possible.

____

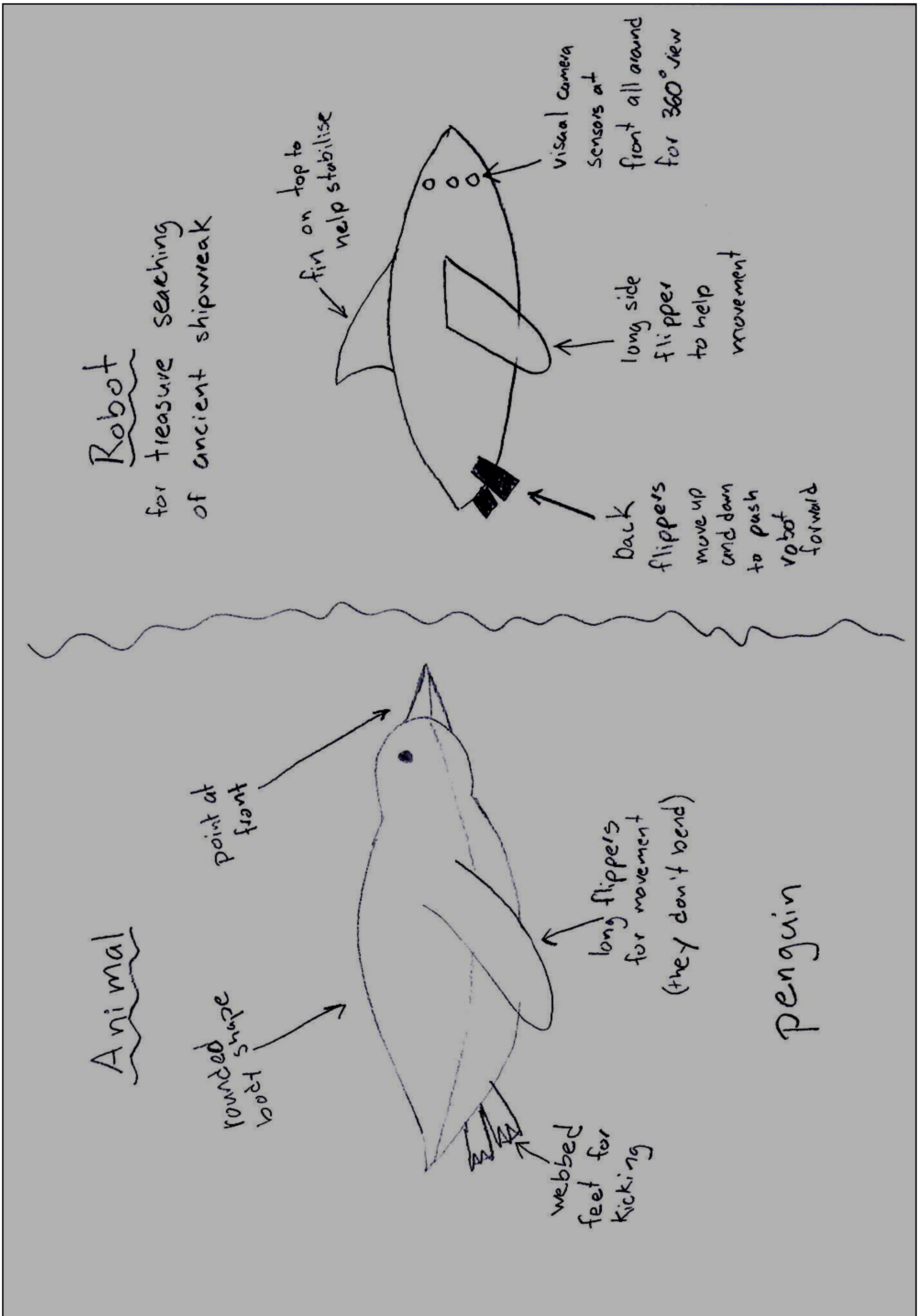
____

____

Sketch what your robot might look like on the back of this worksheet. Label any specific shapes or features which might be useful to help the robot function.

Bio-inspired Robotic Design— example sketches

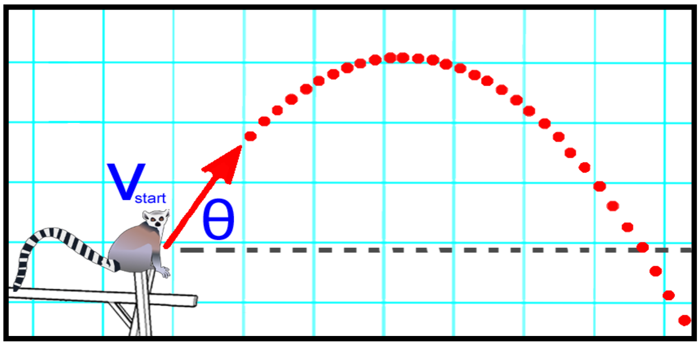
These are example sketches to show what students could develop based on the worksheet on the previous page.



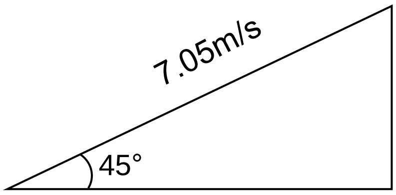
Enclosure Design - Jump Distance Page

Enclosures are designed to meet the needs of animals while ensuring animals and humans stay safe by keeping the animals contained. Some animals are very good at climbing. In order to maintain their health and welfare, they are provided with climbing structures. Some animals are very good at jumping. To keep everyone safe, these animals need to have secure enclosures. Many of them have roofs, but if it doesn't have a roof, the walls of the enclosure must be high enough to stop the animal jumping out.

Go to the ring-tailed lemur enclosure visible from the 'bridge' (accessible at the end of the tunnel by leopards and anteaters, or for the other end of the bridge which starts at meerkats/geladas). This is an open topped enclosure with a climbing frame in the middle.



The lemur jumps off the climbing frame at a velocity (V_{start}) of 7.05m/s at an angle θ of 45° above the horizontal. **Will the lemurs be able to jump out?**



1) Determine the vertical and horizontal components of the initial velocity.
$V_{vertical} = V_{start}\sin(\theta)$
$V_{vertical}$ = ______________________________

$V_{horizontal} = V_{start}\cos(\theta)$
$V_{horizontal}$ = ______________________

2) Calculate how long the lemur will be in the air. Remember, as the lemur jumps, it will reach the top of it's jump and start falling back towards the ground, but its velocity is constant.
$V_{vertical}$ = (from calculation 1)=_____________________
Ending $V_{vertical}$ = (from calculation 1, but is negative)= - _______________ (this is a negative number as by the end of the jump, the lemur is moving downwards)
a = g = $-9.8m/s^2$ (this is negative because the acceleration is downwards).

Ending $V_{vertical}$ = Starting $V_{vertical}$ + a*t
Solve for t (time)

3) Calculate how far (x) the lemur can jump from the top of the post.
Distance = $V_{horizontal}$ * t

4) Estimate the distance from the top of the climbing frame to the fence _____________________________

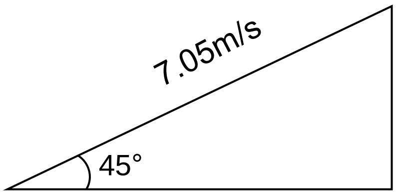
5) Will the lemur be able to jump out of the enclosure? ____

6) The final comparisons involved the use of estimates. What possible effect could this have on your calculation if the lemurs could jump out? On the back of the page, explain why understanding the potential shortcomings of estimates is important.

Enclosure Design - Jump Distance Page

The lemur jumps off the climbing frame at a velocity (V_{start}) of 7.05m/s at an angle θ of 45° above the horizontal. **Will the lemurs be able to jump out?**

1) Determine the vertical and horizontal components of the initial velocity.
$V_{vertical} = V_{start}\sin(\theta)$
$V_{vertical}$ = 7.05m/s * sin(45°) = 7.05m/s * 0.85 = 5.99m/s



$V_{horizontal} = V_{start}\cos(\theta)$
$V_{horizontal}$ = 7.05m/s * cos(45°) = 7.05m/s * 0.53 = 3.74m/s

2) Calculate how long the lemur will be in the air. Remember, as the lemur jumps, it will reach the top of it's jump and start falling back towards the ground, but its velocity is constant.
Starting $V_{vertical}$ = (from calculation 1)=5.99m/s
Ending $V_{vertical}$ = (from calculation 1, but is negative= - 5.99m/s (this is a negative number as by the end of the jump, the lemur is moving downwards)
a = g = $-9.8m/s^2$ (this is negative because the acceleration is downwards).

Ending $V_{vertical}$ = Starting $V_{vertical}$ + a*t
Solve for t
- 5.99m/s = 5.99m/s +($-9.8m/s^2$ *t)
t = (- 5.99m/s - 5.99m/s) /($-9.8m/s^2$)
t= (-11.98m/s)/($-9.8m/s^2$)
t = 1.22s

3) Calculate how far (x) the lemur can jump from the top of the post.
Distance = $V_{horizontal}$ * t
Distance = 3.74m/s * 1.22s = 4.56m

4) Estimate the distance from the top of the climbing frame to the fence This is an estimate, so all the students answers will be different but it should be approximately 4-7m

5) Will the lemur be able to jump out of the enclosure? This is dependent on their estimate of how far the fence is from the climbing frame. If their estimate is large than the jump distance of 4.56m, the lemur can not jump out. If their estimate is smaller than the jump distance of 4.56m the lemur may be able to jump out.

To simplify the worksheet, leave question 6 off
6) The final comparisons involved the use of estimates. What possible effect could this have on your calculation if the lemurs could jump out? On the back of the page, explain why understanding the potential shortcomings of estimates is important.
Many students will have calculations which show the lemurs being capable of jumping the fence. Visual observations show that the lemurs clearly can not jump the fence. Their 'incorrect' (when compared to real life observation) answer is due to the estimates. Students may elaborate further into design problems based on estimates in their answer.

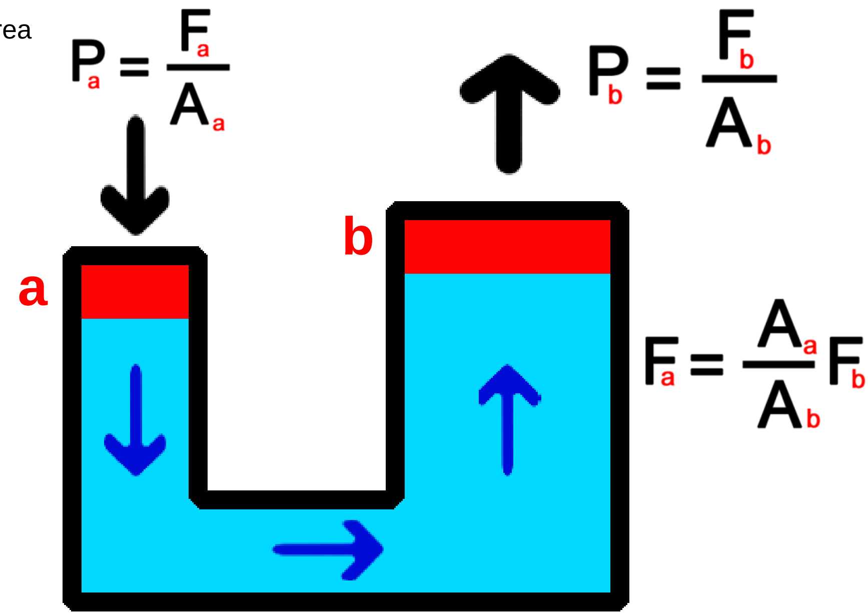
Enclosure Design - Hydraulic Forces

Pressure can be transmitted through liquids. In hydraulic machines, exerting a small force over a small area can lead to pressure being transmitted, creating a large force over a large area. This ability to multiply the size of forces allows hydraulics to be used in many applications such as car-braking systems, or moving heavy elephant proof gates in the elephant enclosure.

Example Pressure = force ÷ cross-sectional area
Force in a = 30N
Area of a = $0.2m^2$
Area of b= $1.0m^2$
Pressure at a = 30N ÷ $0.2m^2$ = 150 N/m^2
(remember, P at A = P at B
because pressure is constant in liquid)

Force at b = (area b ÷ area a) x Force a
Force at b = ($1.0m^2$ ÷ $0.2m^2$) x 30N = 150N

Or, using the other formula...
Force at b = Pressure x cross-sectional area
Force at b = $150N/m^2$ x $1.0m^2$ = 150N



Visit the elephant enclosure, and answer the following questions.
1) How many elephants are there? ___________________________

The average force of Colchester Zoo's elephants is 50,000N
The average area of each foot is $0.07m^2$

2) The pressure exerted by one elephant =
(hint: remember how many feet the elephant has!)

3) If all the elephants stood in the same area at the same time, how much pressure could they exert working together?
(show your work) ____
____

The elephant gate which is operated hydraulically is 3m high and 6m long.
4) What is the area of the elephant gate: ___________________m^2

The keeper operated side of the hydraulic gate system has an area of $0.015m^2$
5) Based on your calculation of pressure in question 3, what is the MINIMUM amount of force the keepers need to use on the keeper side of the door, to ensure the pressure on the elephant side of the gate is at least as much as the pressure if all the elephant stood against the gate. (hint imagine 'a' as the keeper side and 'b' as the elephant side)
(show your work) ____
____

6) Given that an average human can exert a maximum force of approximately 675N when pushing horizontally (when braced against the floor), is this enclosure safe?
(Can the keeper exert enough force on their side to be greater than the force of the elephants pushing on the other side)
____
____
____

Enclosure Design - Hydraulic Forces - Teacher Answers

Teacher answers for the 'Enclosure Design - Hydraulic Forces' worksheet on the previous page.

Visit the elephant enclosure, and answer the following questions.

1) How many elephants are there? 4 elephants (there are a maximum of 4, depending on how many elephants the students saw, this number might be lower. This number, whatever it is, should be used in part 3).

The average force of Colchester Zoo's elephants is 50,000N

The average area of each foot is $0.07m^2$

2) The pressure exerted by one elephant = P = FxA = 50,000N / ($0.07m^2$ x4 feet) = 50,000N / $0.28m^2$ = 178,571 N/m^2

(hint: remember how many feet the elephant has!)

3) If all the elephants stood in the same area at the same time, how much pressure could they exert working together?

(show your work) 178,571 N/m^2 per elephant x 4 elephants = 714,285 N/m^2

(This answer might be different depending on how many elephants they wrote they saw in question 1)

The elephant gate which is operated hydraulically is 3m high and 6m long.

4) What is the area of the elephant gate: 3m x 6m = $18m^2$

The keeper operated side of the hydraulic gate system has an area of $0.015m^2$

5) Based on your calculation of pressure in question 3, what is the MINIMUM amount of force the keepers need to use on the keeper side of the door, to ensure the pressure on the elephant side of the gate is at least as much as the pressure if all the elephant stood against the gate. (hint imagine 'a' as the keeper side and 'b' as the elephant side)

(show your work)

$$F_a = \frac{A_a}{A_b} F_b$$

Using the formula given at the top of the page

Force at the keeper side = ($0.015m^2$ / $18m^2$) x 714,285 N/m^2

Force at the keeper side = ($0.0008m^2$) x 714,285 N/m^2

Force at the keeper side = 571 N

(The specific answers might be different depending on how many elephants they saw in question 1; the 'force b' should be the force they calculated in question 3)

6) Given that an average human can exert a maximum force of approximately 675 N when pushing horizontally (when braced against the floor), is this enclosure safe?

(can the keeper exert enough force on their side to be greater than the force of the elephants pushing on the other side)

Yes, the enclosure is safe. The amount of force needed for the keeper to close the door if all four elephants are pushing with all four feet against the gate (which would be quite difficult as they need to balance) is only 571 N. In the unlikely event that all four elephants were pushing against the gate with all their total combined force, given that the human can (if needed) push with a force of 675 N, they can easily exert at least 571 N of force.

Enclosure Design—Engineering strength

Enclosures are designed to meet the needs of animals while ensure animals and humans stay safe by keeping the animals contained. Some animals are very strong, much stronger than humans. In order to keep everyone safe, these animals must have secure enclosures. The materials the structure are made of must be able to withstand the force the animals could place on them.

Go to the Chimpanzee Lookout, near the main entrance and across from the large outdoor play area. Answer the following questions to find out if this enclosure is strong enough to contain the chimpanzees.

1) How many chimpanzees do you see? ____________________

2) The average mass of a chimpanzee is 50kg. Using this average, what is the weight of a chimpanzee?
Remember, weight (N) = mass (kg) × gravitational field strength (N/kg)
Gravitation field strength = 10N/kg

Weight of one chimpanzee =

3) What is the weight of all the chimpanzees together?
Total weight =

4) On the back of this page, draw a force diagram showing the forces acting on the mesh roof of the enclosure, as if all the chimpanzees were hanging from the roof very close together. Label the diagram and include arrows showing the direction of the force.

5) What is the minimum weight that the mesh roof needs to be able to support in order to ensure the chimpanzees are secure?

Enclosure Design—Engineering strength - Teacher Answers

Enclosures are designed to meet the needs of animals while ensure animals and humans stay safe by keeping the animals contained. Some animals are very strong, much stronger than humans. In order to keep everyone safe, these animals must have secure enclosures. The materials the structure are made of must be able to withstand the force the animals could place on them.

Go to the Chimpanzee Lookout, near the main entrance and across from the large outdoor play area. Answer the following questions to find out if this enclosure is strong enough to contain the chimpanzees.

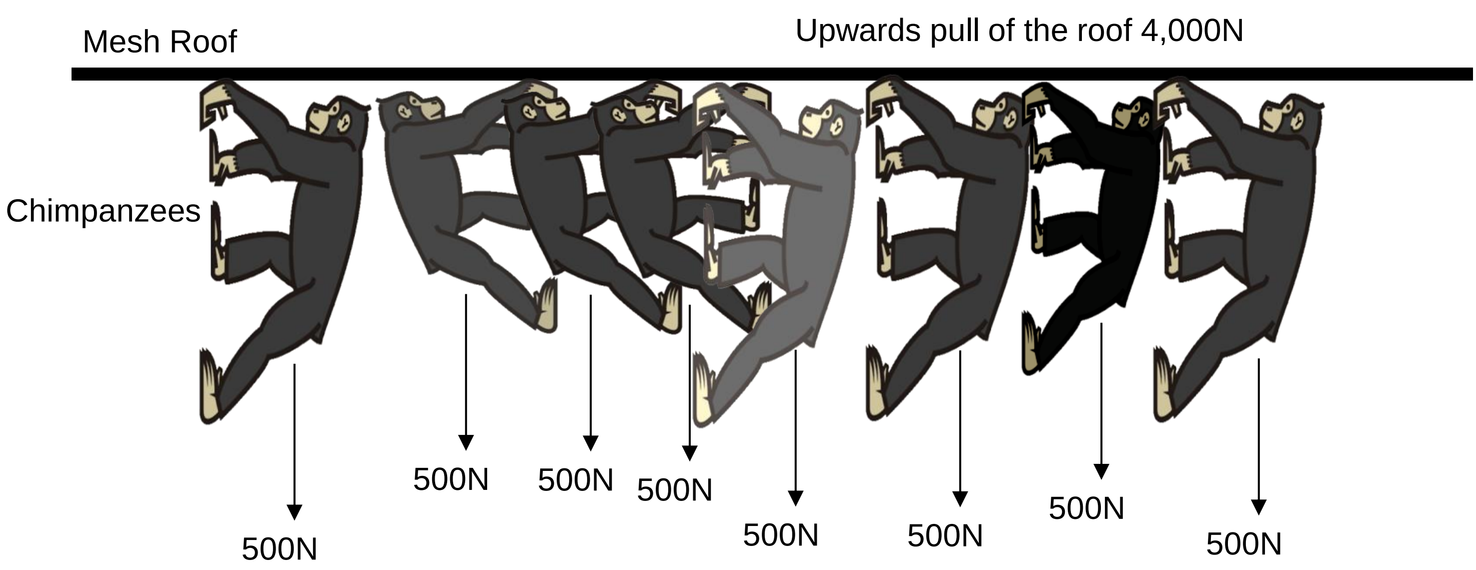
1) How many chimpanzees do you see? Based on visual observation, there are a maximum of 8 chimps, but they may have observed less.

2) The average mass of a chimpanzee is 50kg. Using this average, what is the weight of a chimpanzee?
Remember, weight (N) = mass (kg) × gravitational field strength (N/kg)
Gravitation field strength = 10N/kg

Weight of one chimpanzee = 50kg * 10N/Kg = 500N

3) What is the weight of all the chimpanzees together?
Total weight = 500N/chimp * (number of chimpanzees they recorded in question 1)
e.g. 500N/chimp * 8 Chimps = 4,000N

4) On the back of this page, draw a force diagram showing the forces acting on the mesh roof of the enclosure, as if all the chimpanzees were hanging from the roof very close together. Label the diagram and include arrows showing the direction of the force.



The diagrams may look different, but should all show the same number of chimpanzees recorded in question 1, and the weight as a force with an arrow for each chimpanzee. The counteraction force up from the mesh roof should show the TOTAL force counteracting the weight of all the chimpanzees (question 3 and 5)

5) What is the minim weight that the mesh roof needs to be able to support in order to ensure the chimpanzees are secure?
This is the same answer as question 3. E.g. 4,000N

Enclosure Design —Slope Erosion

Enclosures are designed to meet the needs of animals while ensure animals and humans stay safe by keeping the animals contained. Colchester Zoo is a very hilly location, and many animal enclosures incorporate hills into their design. On steep hills, gravity moves earth, rock, and soil material downslope. This happens slowly (millimeters per year), or may happen very suddenly (e.g. rock fall or landslide). During heavy rainfall, water entering soil increases its weight, and can cause it to suddenly slide down.

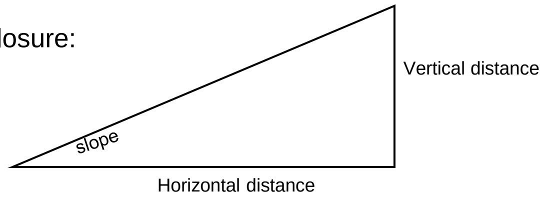
Soil erosion can be limited by growing plants. Plants have roots which help to hold the soil together and prevent it rolling or sliding downhill. Larger plants generally have deeper roots. Ground cover plants may have thick matted roots which firmly hold everything in place. Soil erosion can also be prevented by building retaining walls, or other physical structures to turn the slope into a 'stair-like' structure rather than a straight slide (in landscaping these small steps are often called 'terraces'). Another way to prevent erosion is to limit the water flowing over the slope. This can be done by developing specific lined channels for water run-off rather than letting it flow over the entire surface of the slope.

Visit the sun bear enclosure which is on a very steep slope. Examine the enclosure from the top (the entrance is across from leopards at the top of the very steep hill), and the bottom (in between butterflies and penguins). Answer these questions to try and determine why the enclosure was designed the way it is.

1) Looking from the top, estimate how far it is across the enclosure (the distance from the top viewing window in a straight line to directly above the lower viewing windows) ________________________m

2) Looking from the top, estimate how far down the lower viewing windows are vertically __________________m

3) Based on your estimates, calculate the slope of the bear enclosure:



Slope = rise/run = vertical distance / horizontal distance
Slope = _________________
Slope % = Slope * 100% = __________%

4) Slopes greater than 15% are at greater risk of soil erosion. Is this slope at risk of soil erosion, why or why not?

5) Go to the bottom of the bear enclosure. Looking up the slope, what features can you see which help limit soil erosion on the slope? Describe at least two.

Enclosure Design —Slope Erosion - Teacher Answers

Visit the sun bear enclosure which is on a very steep slope. Examine the enclosure from the top (the entrance is across from leopards at the top of the very steep hill), and the bottom (in between butterflies and penguins). Answer these questions to try and determine why the enclosure was designed the way it is.

1) Looking from the top, estimate how far it is across the enclosure (the distance from the top viewing window in a straight line to directly above the lower viewing windows) This is an estimate, so every student will be different. It should be between approximately 28m-35m

2) Looking from the top, estimate how far down the lower viewing windows are vertically This is an estimate, so every student will be different. It should be between approximately 10m-15m

3) Based on your estimates, calculate the slope of the bear enclosure:

Slope = rise/run = vertical distance / horizontal distance

Slope = 10m/30m = 0.33

Slope % = Slope * 100% = 0.33*100% = 33%

These numbers should be based on whatever their estimates in question 1 and 2 were

4) Slopes greater than 15% are at greater risk of soil erosion. Is this slope at risk of soil erosion, why or why not?
This slope is at risk of soil erosion. Depending on their estimates, they may have a slightly different percentage, but their estimates should still have resulted in a slope % (question 3) greater than 15%.

)Go to the bottom of the bear enclosure. Looking up the slope, what features can you see which help limit soil erosion on the slope? Describe at least two.

There are a number of features which could be described including:

- Plants - both large trees with deep roots, and grass/other ground cover with matting roots
- Terracing to the hill through the use of artificial rock work
- Channels for water and water runoff to flow along (over top of the artificial rock work rather than just over the soil)

Enclosure Design - Green Technology

When the Dragons of Komodo enclosure was built in 2006 it used state of the art technology to make it as environmentally friendly as possible. A lot of this technology is behind the scenes and not immediately obvious when looking at the enclosure. Visit the enclosure (down the hill from chimpanzees on the way to wolves and tigers) and try to answer these questions based on your observations.

1) Komodo Dragons are reptiles which require high temperatures. These temperatures are maintained by a special 'greenhouse' roof which heats the enclosure through passive solar heat. This works very well in winter. In summer, it can almost get too hot. Look closely at the enclosure roof, how do you think it functions to cool off the enclosure in summer? (hint: adult komodo dragons can't climb) ________________________________
____
____
____
____

2) Komodo Dragons require a high level of moisture in the air. To achieve this, there are sprinkler systems and pools in the enclosure. Where do you think this water comes from to make it as environmentally friendly as possible?________________________________
____
____
____
____

Due to its source, this water is filtered before being put into the enclosure. To do this, it needs large holding tanks and a filter system. Where do you think these are stored? (hint: are you standing at ground level? As you walk along, where do you go back to ground level) ____
____
____
____
____
____
____

3) When it was built in 2006, many of the features of this enclosure were state of the art. Technology has changed a lot since 2006. Looking around the enclosure, what do you think could be improved or changed by using more modern technology to make it more environmentally friendly? ____
____
____
____
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____
____
____

Enclosure Design - Renewable Energy

Visit the Butterfly House (located at the bottom of the step hill by leopards) and answer these questions.

Describe the temperature of the butterfly house:

Do you think it is important to maintain this temperature? Why?

How is the butterfly enclosure heated? (hint: look all around the building, even outside to find this answer)

What is one benefit of this type of heating system?

Why do you think this type of energy is classified as ‘renewable energy’? (hint: think about what you know about plants)

For PRIMARY AGE pupils ONLY

Engineering—Play Area Design

Engineering, physics, forces

Visit the Remi Brown Play Area, close to the Hyenas beyond the elephants and the Africa paddock.
Please note that only Primary age children are allowed in the play area.

Investigate the playground. Use the equipment and try to figure out how it works. After your investigation, draw one piece of equipment. On your drawing, make sure to include a person playing.
Using the wordbank at the bottom of the page, label the drawing. Add in any extra labels or descriptions you think explain how the equipment works.

WORDBANK						
Gravity	Push	Pull	Slide	Lever	Person	
Turn	Pivot	Movement		Sound	Echo	Soft
Hard	Grab	Handle		Seat	Step	Ladder
Chain	Metal	Plastic		Wood	Fastener	Rope
Roof						

Technology and Visitors

Many zoos are starting to use technology as a way to engage the visitors. As you walk around the zoo, answer these questions to find out how Colchester Zoo uses technology for its visitors.

Choose an animal enclosure: ____
What technology has been used at this enclosure for visitors? (remember to include things like graphic design, sound systems, etc.) __________________
____
____
____
____

What technology do you think could be added to the enclosure to improve the visitor experience? (e.g. CCTV, animatronics, etc.)
____
____
____
____
____
____
____

Look for different types of technology relating to the visitor experience (e.g. till systems, AR experiences, interactive playarea, computer presentations). List at least 10 and describe if you think the technology is used well and if not, how it could be improved.

1)____

2)____

3)____

4)____

5)____

6)____

7)____

8)____

9)____

10)____

Tech and Conservation - Save the Rhinos - Page 1

Rhinoceroses are endangered. In the past few years their population worldwide has seen a 95% decrease. Within the next few years rhinos could be extinct. The reason for this decline is the illegal trade in rhino horn on the black market. Many people worldwide think rhino horn has medicinal properties which can treat a range of illnesses. There is no medicinal benefit of rhino horn, but people are still willing to pay a lot for it, which is why there is a huge demand for the horn. Currently, there are a lot of projects using technology, in use or being developed to help save the rhino. These projects include:

- Installing CCTVs with thermal imaging cameras to track all people and vehicles entering rhino reserves (to track for poachers and compare against existing facial and vehicle license plate lists).

- Equipping rhinos with heart-rate monitors and GPS - if the rhinos become stressed, the monitors trigger an alarm and rangers can immediately respond to the area to find out why (in case the stress is caused by poachers)

- Patrolling rhino reserves with drones.

- Installing cameras with live video feeds into rhino horns (drilling a hole into the horn, which is painless for the rhino). Poachers could still kill the animals, but will be tracked on video (with the film sent to a secure other location wirelessly) the whole time.

- Creating ‘robotic rhinos’ which will travel with the herds of white rhino. By being ‘rhino-like’ the animals will accept it, and it can then stay with the herd the entire time. Powered by hydrogen/solar it won’t need charging. If poachers approach it can fight them (potentially equipped with weapons) and/or alert authorities.

- Creating synthetic rhino horn in a lab and using 3D printers to mass produce them. These ’fake’ horns are indistinguishable from the real thing. These can be used to ‘flood’ the black market There will be so many rhino horns available, no one will need to kill actual rhinos to buy it.

- Injecting rhino horn with chemicals which make it impossible to use as medicine as it would hurt people if consumed. The chemicals make the horn bright colours so it is obvious. The chemicals do not hurt the rhinos.

Tech and Conservation - Save the Rhinos - Page 2

At Colchester Zoo, observe the rhinoceroses (in the mixed Africa Paddock near the Giraffe House. If they can't be seen outside go inside the Giraffe House and look for them through the viewing windows or from the balcony). After your observations, select one of the technologies from the previous page and write why you think it **will not work,** based on your observations of the rhinos. Next, select one of the technologies you think **could work**, based on your observations, and explain why.

A technology which I think will not help save the rhinos is….__________________,
because ____
____
____
____
____
____
____
____.

A technology which I think will help save the rhinos is….______________________,
because ____
____
____
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____
____.

Based on your observations of the rhinos, think of a different technology (not mentioned on the previous page) which could be used to help save the rhinos. Explain your idea: ____
____
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____.

Genetics - Cheetahs and Bottlenecks

At Colchester Zoo, visit the cheetahs. Based on your observations and reading the signs at the enclosure, answer the following questions.

How many species of cheetahs did there used to be? ____________________

How many species of cheetahs are there now? _________________________

An evolutionary bottleneck occurs when there is a sudden decrease in the number of animals which results in only a few individuals surviving. This could be caused by earthquakes, floods, disease, over-hunting, etc.

What event caused the cheetah genetic bottleneck? ____________________

____

____

What is one problem of having a restricted gene pool (low genetic diversity)?

____

Observe the cheetahs. Does it seem to have any problems, or is it healthy?

____

____

____

____

____

How should zoos work together to ensure the genetic diversity among the population of cheetahs living in zoos?_________________________________

____

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Native Wildlife - Habitat Assessment

Visit the Nature Area (through the tiger viewing tunnel).

Look at the entire area, paying attention to the 'type feature being assessed'. After your examination, assign each feature a ranking (3-0) by circling the appropriate description. After ranking everything, sum all the points in each column, then sum all the points together to get a total score for the habitat.

		Ranking			
		3 points	**2 points**	**1 point**	**0 point**
Type of Feature being Assessed	**Number of large trees**	Many large trees	4-5 large trees	1-3 large trees	No large trees on site
	Understory plants	Many shrubs, bushes, reeds, etc.	Scatted clumps of shrubs, bushes, etc.	A few shrubs	No understory plants
	Logs, rotten trees, and other large woody debris	Many logs and other large woody debris	A few logs and other large woody debris	1 log	No logs or large woody debris
	Connectivity to other nearby habitats	Area appears to connect to surrounding forest/streams/etc.	Forests/streams/etc. visible nearby but not connected (field or similar separating them)	Forests/streams/etc. visible nearby but not connected (road or similar separating them)	No forests/streams or other habitats visible nearby
	Water Quality	Water flowing and appears clear; no smell.	Water flowing slowly; slightly cloudy (hard to see through); no smell	Water still; very cloudy (can't see the bottom at all); no smell	Water still; very cloudy (can't see the bottom at all); strong bad smell
	Water Plants	A variety of different plants growing in the water	One type of plant completely covering all the water	A few scattered, sickly looking plants	No plants growing anywhere near the water
	Water Channel Complexity	Water in a variety of channels; bendy streams connecting multiple small pools and ponds	Water in a variety of channels; completely straight streams connecting multiple round pools and ponds	Water only in one main channel.; completely straight stream linking one round pool	Water only in one completely straight stream (no larger ponds or pools)
	TOTAL POINTS in each Column				
			TOTAL SCORE for the entire habitat (sum together all of your totals from each column)		

Quality of Habitat based on numbers of point:
Excellent Habitat 25-35 points Good Habitat 15-25 points Okay Habitat 5-15 points Poor Habitat 0-5 points

Based on your assessment, what quality is the nature area:____________

What could be added or changed to make the nature area a better habitat:

____

____

____

____

Train - Designing a Vehicle

Design, forces, movement, vehicles

This activity involves riding the train. The train station is located near tigers, and the train takes visitors to the walk-through lemur enclosure. Please note that all school pupils must be accompanied by adult supervisors when riding the train.

Draw the train engine

On your drawing, label the wheels, driver's seat, and any parts that light up.

How many carriages is the train pulling:

____

How many people can sit in each carriage?

____

How many people can ride the train? _______

How many wheels does the engine have? ________

How many wheels does each train carriage have? _____

On the back of this page, draw a new design for a train. Make sure your new train can fit the same number of passengers as the existing train.

Train - Functionality and Design

This activity involves riding the train. The train station is located near tigers, and the train takes visitors to the walk-through lemur enclosure. Please note that all school pupils must be accompanied by adult supervisors when riding the train.

1) How many carriages was your train pulling? ____

2) Approximately how many people can fit in each carriage? ____________________________________

3) Approximately how many people could ride the train at one time? ______________________________

4) Estimate the length of the train queue by walking it's length and counting your steps: _______________

5) How many people could be waiting in the queue (only count the area past the train queue sign): _________

6) Pay attention to the route the train takes as it drives to the lemurs and back. Sketch a diagram showing the route below. Try to make it as to scale as possible.

7) Adding more carriages to the train would allow it to carry more passengers. Given the number of visitors who could be waiting to ride (and the actual number could be much higher as the queue could continue past the official queuing area), why do you think the train has this number of carriages? Think of at least two reasons and describe then in detail below.

a) ____

____

____

____

____

b) ____

____

____

____

____

Post-Trip Classroom Ideas:

These are ideas to help your class focus on STEM after a trip to the zoo. Use these ideas with or without the activities and worksheets on the previous pages.

1. Research bio-inspired robots based on animals you saw at the zoo. Watch videos of the robots online and discuss how similar the robots seem to the animals that inspired them.

2. Research conservation projects that use technology to save endangered animals. For example: ferret drone medication, smart collars, texting elephants, SMART hooks, wildleaks, etc.

3. Get involved in citizen science conservation projects using technology, such as identifying animals from camera trap photos, or tagging penguins in colony photos.

4. Develop and post online reviews of your visit to websites.

5. Set up an aquarium in your classroom without live fish (just use plastic ones), but with a working filter. Experiment by changing different variables and creating hypothesis about what will happen to the water quality. For example, place it in sun light, add lots of fish food (even though there are no live animals), add salt, add vinegar, place live plants in it. Test different water parameters including salinity, pH, hardness, nitrite, nitrates, ammonia, etc. Test kits are available cheaply from most aquarium/pet stores.

6. Design an online photo blog/story/website based on the trip to the zoo

7. Design zoo enclosures based on research conducted at the zoo. Construct the enclosures out of materials and discuss as a group, strength and weaknesses of all the designs.

8. Research endangered animals and threats they are facing. Working in small groups think of creative ways these threats could be solved by the use of technology.

9. Build model animals (from clay, papier-mâché, pipes and bolts, etc.) focusing on imitating the function and form.

We hope you enjoyed your trip to

COLCHESTER ZOO

Action for the Wild

Learning about

STEM

SCIENCE TECH ENGINEERING MATHS