

## **The Living World**

### ***Checklist***

1. Describe a given population (density, distribution, biological cycles)
2. Describe the influence of biotic or abiotic factors on the biological cycles of a population (natality, mortality, immigration, emigration)
3. Explain how the availability of resources in the environment affects reproduction and survival
4. Define a community as a group of populations that interact
5. Define an ecosystem as the relationships between the individuals in a community and abiotic factors in the environment
6. Define the biodiversity of a community as the relative abundance of species it comprises
7. Explain factors that affect the biodiversity of a given community
8. Define a disturbance in a community
9. Explain the effects of certain factors that disturb the ecological balance (e.g. human activity, natural disasters)
10. Describe the trophic levels (producers, consumers, decomposers)
11. Explain the relationships between the trophic levels of a food web
12. Define primary productivity as the quantity of organic matter produced by plants in a given territory
13. Explain the effects of certain factors on primary productivity (e.g. bees help pollinate fruit trees, pathogenic microorganisms hinder plant growth)
14. Describe material and energy flow in an ecosystem
15. Describe certain processes underlying chemical recycling (e.g. action of microorganisms and decomposers, erosion)

## Populations

1. To an ecologist, individuals are singular organisms of a given species. For example a person is a single individual *Homo sapiens*.

What does the term "population" mean to an ecologist?

A group of organisms of the same species living in the same place, using the same Resources.

2. What is the difference between population size and population density?

Pop. Size = Total number of organisms in the population  
" Density = Number of organisms per unit area

3. You want to find out the size of a poppy population in a field of  $10\,000\text{m}^2$ , so you count the average number of poppies in two-square meter ( $2\text{m}^2$ ) quadrants. You determine that the average number of poppies per quadrant is five.

What is the size of the poppy population in the entire field?

$$\frac{10\,000\text{m}^2}{2\text{m}^2/\text{quadrants}} \times \frac{5\text{ poppies}}{1\text{quad}} = 25\,000\text{ poppies}$$

4. The fin whale is the second largest living animal on the planet right now. However it is endangered and its populations are at risk. In the 1980s scientists tagged 30 fin whales in the north Atlantic. In 1992, 20 whales were "captured" and examined for tags. Of those 20 whales only one was tagged.

What would the estimated size of the fin whale population in the north Atlantic be?

$$\frac{\overset{\text{tagged}}{30\text{ whales}}}{\text{total Pop}} = \frac{1\text{ tagged whale}}{20\text{ recaptured}} \quad \begin{aligned} \text{Total Pop.} &= 20 \times 30\text{ whales} \\ \text{Pop.} &= 600\text{ whales} \end{aligned}$$

5. At the Huntsman marine research centre, marine biology students are examining the health of the periwinkle population (a type of snail). The students have used zonation research to find that the average population density of the periwinkles is 16 animals per  $4\text{m}^2$ .

What is the total population size of the periwinkles across the  $170\,000\,000\text{m}^2$  coastline of the Bay of Fundy?

$$\frac{16 \text{ periwinkles}}{4 \text{ m}^2} \times 170\,000\,000 \text{ m}^2 = 680\,000\,000$$

$$\text{Total Pop.} = 680\,000\,000 \text{ periwinkles}$$

$$\text{or} \\ 6.8 \times 10^8 \text{ periwinkles}$$

6. Captain Zack Marrow is terrified of earthworms. Unfortunately, his old buddy Jack has given him a  $0.5\text{m}^3$  jar of dirt for his birthday. The population density of earthworms is 10 worms per cubic-meter of dirt.

How many worms are in Captain Zack Marrow's jar?

$$\frac{10 \text{ worms}}{1 \text{ m}^3} \times 0.5 \text{ m}^3 = 5 \text{ Worms}$$

7. In a  $500\,000\text{km}^2$  African wildlife park, there are 20 000 giraffes.

What is the density of giraffes per square-kilometer?

$$\frac{20\,000 \text{ giraffes}}{500\,000 \text{ km}^2} = 0.04 \frac{\text{giraffes}}{\text{km}^2}$$

8. A recent research study in Montreal determined that there are 800 Red Maple trees in Parc du Mont-Royal. The park covers an area of 200 hectares.

What is the population density of Red Maple trees in Parc du Mont-Royal?

$$\frac{800 \text{ Trees}}{200 \text{ hectares}} = 4 \text{ Trees per hectare}$$

9. Last year, 24 deer were captured and marked in an effort to determine the size of the deer population in Nevins Park. This year, a second group of 27 deer were captured. Of these 27, there were 18 marked deer. The park measures 12.85 km by 3.5 km and is a perfect rectangle.

What is the population density of the deer in Nevins Park?

<p>Pop.</p> $\frac{18 \text{ marked Deer}}{27 \text{ Recup}} = \frac{24 \text{ Marked}}{\text{Total Pop.}}$ <p>Total pop. = 36 Deer</p>	<p><math>12.85 \text{ km} \times 3.5 \text{ km} = 45 \text{ km}^2</math></p> <p>Pop. Density = <math>\frac{36 \text{ Deer}}{45 \text{ km}^2} = 0.8 \frac{\text{deer}}{\text{km}^2}</math></p>
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10. Populations of organisms will have different distributions depending on the type of organism and their habitat. For the following populations indicate if the distribution is: **clumped**, **uniform** or **random**.

Organisms	Distribution
Anchovies, a fish that swims around in large groups called schools.	Clumped
Solitary predators like tigers allow each other equal territorial spacing to avoid fights and injuries.	uniform
The balsam poplar tree can reproduce asexually. They show up un inconsistent and unusual patterns in Quebec's forests	random
Dandelion seeds are spread by the wind, which changes constantly in the summer months.	random
Penguins stick together during cold nesting months at all times to conserve heat.	Clumped
Fungi secrete poisons that kill rivals that grow too close.	uniform

11. Many animals travel in groups for protection, these groups have many names: schools of fish, pod of whales, crash of rhinos, colony of butterflies, business of ferrets, parliament of owls, unkindness of ravens, murder of crows etc.

**What type of distribution does this represent?**

Clumped Distribution

12. When we design classrooms or auditoriums with seating we tend to give everyone the same amount of space for the sake of consistency and fairness. This happens in nature when organisms compete for resources and defend their territory.

**What type of distribution does this represent?**

Uniform or Even Distribution

13. Squirrels are an urban rodent that most Canadians are familiar with. They have adapted to live alongside humans and benefit from our cities and resources. A study of the LaSalle neighbourhood of Montreal found that the squirrel population of that region numbered ~~over~~ 2 000 individuals in 2011. From 2011 to 2013, 4000 squirrels were born, 1200 died of illness or old age and 800 were killed by traffic. In addition 700 squirrels emigrated from LaSalle to Lachine and Verdun.

**What was the final size of the squirrel population in LaSalle?**

$$\begin{array}{r} 2000 \\ +4000 \\ \hline 6000 \\ -1200 \\ \hline 4800 \\ -800 \\ \hline 4000 \\ -700 \\ \hline 3300 \end{array}$$

Final population = 3300 Squirrels

14. Historical human populations are often studied in the same way that ecologists examine populations of other organisms. In the mid-1840s ~~nearly~~ 8 million people lived in Ireland. The potato blight, a fungus that destroyed the Irish food supply caused widespread starvation that killed 1.2 million people (1845-1852). An additional 500 000 died of disease/old age while birth rates declined such that only 150 000 children were born. In addition, 900 000 Irish men and women emigrated from their homeland seeking a better life; the number of immigrants to Ireland was insignificant during this time. What would the human population of Ireland be after the blight, using the information above?

$$\begin{array}{r} 8 \text{ million} \\ - 1.2 \text{ million} \\ - 0.9 \text{ million} \\ + 0.15 \text{ million} \\ - 0.9 \text{ million} \end{array} \quad \begin{array}{l} \text{Irish Population} = 5.55 \text{ million people} \\ \text{or} \\ 5\,550\,000 \text{ people} \end{array}$$

15. Many factors affect the size of a population. These factors can have a range of different effects depending on the nature of the factor and how significant it is.

a) What do we call a factor that prevents a population from growing or reduces the size of a population?

Limiting factor

b) What do we call factors that result from the actions of other living organisms?

Biotic Factor

c) What are two examples of the factors mentioned in B?

Predation, Competition, Prey availability, Disease

d) What is the term for factors that are the result of events that do not involve living organisms?

Abiotic Factors

e) What are two examples of the factors mentioned in D?

pH, Water availability, substrate, temperature, sunlight

16. For the following examples indicate whether the plant or animal population would increase or a decrease in size.

a) Fifty baby black bears are born in Quebec. At the same time seventy black bears cross the border into Ontario.

$20 > 50$

Decrease

b) A rhinoceros population is hunted by poachers for their horns.

Decrease

c) Fish farmers stock a river with salmon fry (immature/young salmon)

increase

d) Forest fires burn down large portions of the black spruce forest.

decrease

e) Cod fishermen off the coast of Newfoundland use massive 2km long drag nets to catch fish in the Labrador Sea.

decrease

f) Canada geese return to Lac Tranquille in the spring.

increase

g) A massive birth boom (50 000) affects the rabbit population in rural New York but twenty-thousand young rabbits are killed by foxes.

$50\,000 > 20\,000$  increase

17. Wapiti are a type of deer; their populations have been studied in Canada for hundreds of years. Recent years have not been kind to the Wapiti, the saplings they eat have been destroyed by fungal disease. Furthermore, the lack of food and energy made the Wapiti easy prey for wolves and hunters alike. The heavy winter snows made for a harsh winter that killed many more of the deer.

**Name one abiotic and one biotic factor that led to a decline in the Wapiti population.**

Biotic

Fungal disease  
Lack of food  
predation

Abiotic

Heavy winter snows

18. The USA and Canada have both been concerned with invasive species in their freshwater ecosystems in recent years. The Asian carp is one species that has garnered particular attention among policy makers, researchers and recreational fishers. The Asian carp feeds on smaller fish and organisms in North American rivers and has no true predators in these waters; even humans don't catch them because they aren't popular as food. Despite not being a native species, the carp can easily adapt to the pH and temperature of North American rivers year-round. They are out competing native fish species and taking over their habitats.

**What are TWO biotic and TWO abiotic factors that the Asian carp overcame to become an invasive fish species in North America?**

Biotic

No predators or predation  
No competition Competition

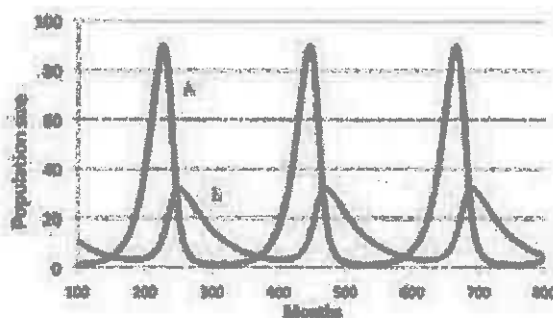
Abiotic

pH and temperatures



### Communities

19. Two populations of organisms are described by the following graph. The two organisms are related to each other through a biological cycle.



What type of interaction exists between species A and B?

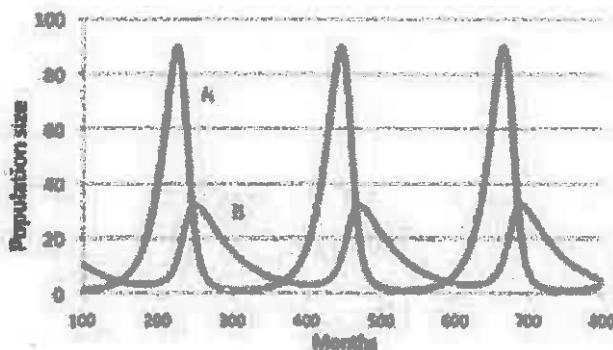
Prey and Predator

20. A biological cycle is sometimes described as a "Phase-shifted sinusoidal function". This means that the wave-like lines are slightly out of sync with one another, the peak of one graph comes slightly after the peak of the other.

Which organism peaks first in the cycle, the prey or the predator?

The prey

21. In this graph, population A represents the gazelles in an African game reserve. Population B describes the lion population on the same reserve. Based on this biological cycle graph what would we expect to happen to population A if the size of population B were to be reduced?



Population A would increase due to reduced pressure (limiting factor) from predators.

22. Addo Elephant National Park serves as a refuge for elephants, buffalos, antelope and birds. As of 2012 Addo park sheltered 30 percent elephants, 30 percent buffalo, 20 percent antelope and 20 percent birds and the Amboseli park sheltered 60 percent giraffes, 30 percent elephants and 10 percent birds

a) Which of these two parks would have greater species richness?

Addo  
4 "species" vs. 3 for Amboseli

b) Which of the two parks has a closer relative abundance of species?

Addo	Amboseli	Addo, species have similar relative abundance
30	60	
30	30	
20	10	
20		

c) Which park has greater biodiversity with respect to these species?

Addo Park, it has greater richness  
and closer relative abundance

23. What does species richness mean in ecology?

It refers to the number of species  
living in an ecosystem  
Greater richness = higher diversity

24. What does relative abundance mean in ecology?

A description of the compared population  
sizes of different species.  
Closer abundance = higher biodiversity

25. How do species richness and relative abundance relate to biodiversity?

High Species Richness = High biodiversity  
 close relative abundance = high biodiversity

26. Grasslands National Park is a park in the Saskatchewan badlands. Paleontologists estimate that 73 million years ago it was home to dinosaurs such as: *Chasmosaurus*, *Edmontosaurus* and *Tyrannosaurus rex*. It has been calculated that Grasslands Park once held 40% *Chasmosaurs*, 55% *Edmontosaurs* and 5% *Tyrannosaurus rex*. In Alberta, Dinosaur Provincial Park is estimated to have held 20% *Chasmosaurs*, 25% *Edmontosaurs*, 20% *Ankylosaurs*, 20% *Gallimimus* and 15% *Dromeosaurs*.

a) Which of these two parks would have had greater species richness?

Dinosaur Provincial Park  
 5 species vs. 3 for Grasslands

b) Which of the two parks had a closer relative abundance of species?

DPP  
 20  
 20  
 25  
 20  
 15

GNP  
 40  
 55  
 5

Dinosaur Provincial  
 Park

c) Which park had a greater biodiversity with respect to these species?

Dinosaur provincial Park has  
 greater richness and closer relative abundance.  
 Therefore it has greater biodiversity

### Ecosystem Disturbances

27. Disturbances to ecosystems come in many forms and from many different sources.

**State one example of a natural disturbance and one example of a human disturbance.**

Natural Disturbance

*Hurricane*

Human Disturbance

*Oil Spill*

28. Determine whether the following disturbances are of natural or human origin.

Disturbances	Human or Natural
The freezing over of a lake or river in the winter	<i>Natural</i>
A volcanic eruption	<i>Natural</i>
An oil spill at sea	<i>Human</i>
A tree struck by lightning	<i>Natural</i>
Open-pit coal mining	<i>Human</i>
Heat waves in the summer months	<i>Natural</i>
A chemical dump from a manufacturing plant	<i>Human</i>

29. What are the three factors that determine how significant or important a disturbance is with respect to how it affects an ecosystem?

1. *Type (Natural vs. Human)*
2. *Intensity or Magnitude*
3. *Frequency*

30. Winter storms affect the north-eastern United States about once or twice a year causing some property damage and loss of human life due to road accidents and low temperatures, the storms sometimes knock over trees due to snow and ice accumulation. Forest fires occur with similar frequency about 2-3 times a year. However they result in the loss of many square kilometers of forest and cause hundreds of millions of dollars in property damage. The forests can take decades to regrow and the smoke released into the atmosphere accelerates global warming.

Which of these types of disturbances is more significant?

Forest Fires - Similar Frequency, both Natural Fires have greater intensity and are much more damaging.

31. What is the process that restores an ecosystem to its stable state after a disturbance?

Ecological Succession

32. What is the difference between a forest fire caused by a lightning strike and a forest fire caused by a lazy camper neglecting to put out their fire?

The lightning strike is a natural occurrence while the campfire-fire is caused by human activity

### Ecosystem Dynamics

33. What does the *biomass* in an ecosystem represent?

The total mass of all living organisms  
in an ecosystem

34. Which of the following are not a part of an urban ecosystem's biomass:

Trees      Foxes      Cars      Humans      Cockroaches  
Dandelions      Racoons      Pigeons      Buildings  
Telephone Wires      Rats      Worms      Mushrooms

35. Which of the following are not a part of a jungle ecosystem's biomass:

Trees      Panthers      River Water      Jungle Wolves  
Giant Cockroaches      Fog/Mist      Birds of Paradise  
Soil      Lemurs      Gorillas      Human Ruins

36. Which of the following are not a part of a river ecosystem's biomass:

Algae      Oil      Fish Fry (baby fish)      Shrimp  
Reeds      Plastic Bags      Water      Ducks  
Clay/Mud      Fish      Bears      Frogs

37. What does the term *chemical recycling* mean in the context of an ecosystem?

The matter in an ecosystem is reused. It cycles  
between living and non-living forms through  
Producers and decomposers

38. What role do *decomposers* play with respect to *chemical recycling*?

They convert organic matter into inorganic matter.

39. What role do *producers* play with respect to *chemical recycling*?

Producers convert inorganic matter into organic (living) matter.

40. What is *primary productivity* in an ecosystem; how does it relate to biomass?

It is the amount of 'new' biomass made by the producers.

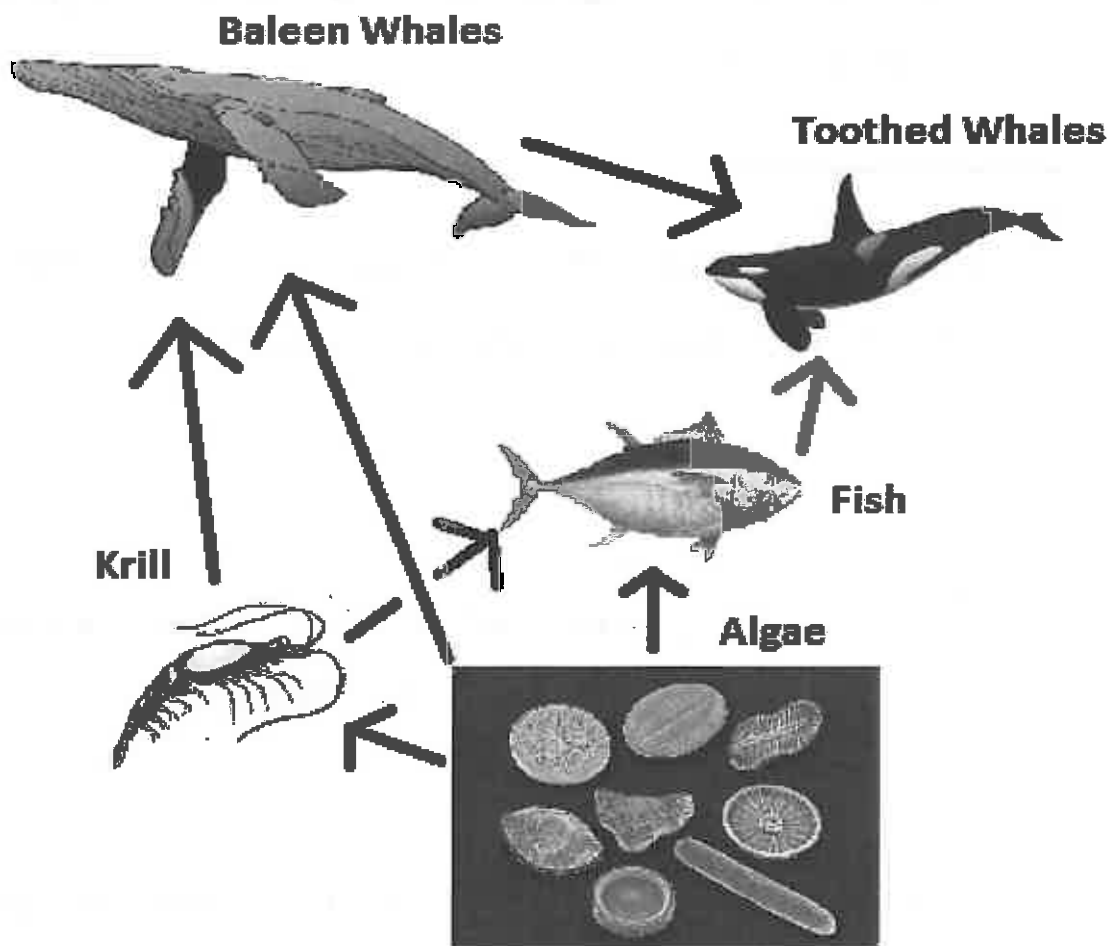
41. Which types of organisms are responsible for *primary productivity* in an ecosystem?

Producers such as plants and algae

42. Which organisms are responsible for *primary productivity* in terrestrial ecosystems?

Plants

Use the marine food web below to answer questions 43-45



43. Indicate the organisms from the food web that belong to the trophic levels below.

Producers	Primary Consumers	Secondary Consumers	Tertiary (Level 3) Consumers
Algae	Krill Fish	Fish Baleen Whales Toothed whales	Toothed whales



44. In the 1800s baleen whales were heavily hunted by humans. This dramatically lowered their populations to 2% of their original size.

a) What would the direct effect of this change be on populations of toothed whales?

Their populations would decrease due to a lack of food.

They might eat more fish.

b) What type of interaction did the *fish* and *baleen whales* have with one another?

Competition over food  
(Krill and Algae)

c) Based on ONLY the relationship described in "b", what would happen to the *fish* population when the *baleen whale* population fell?

It would increase due to less competition which is a limiting factor

d) What type of interaction did the *toothed whales* and *baleen whales* have?

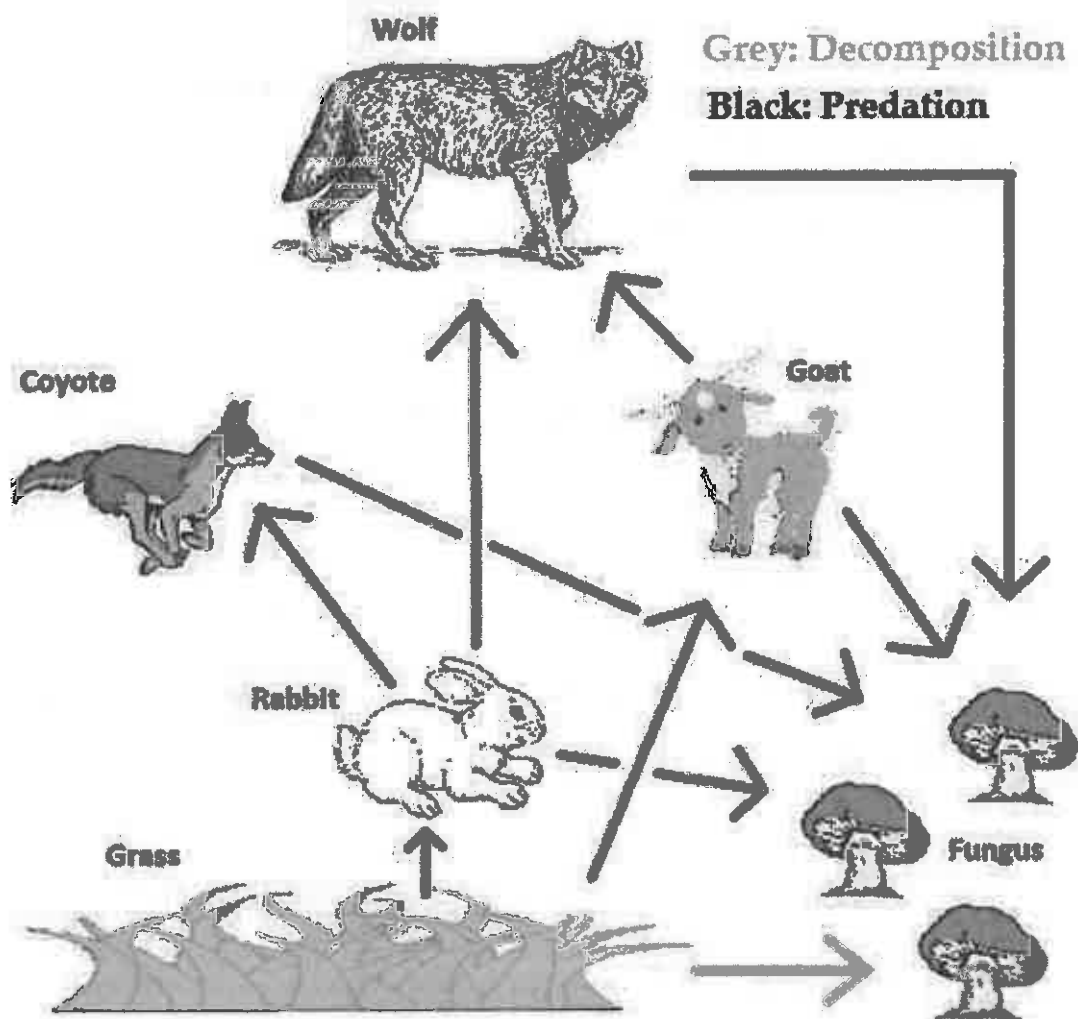
Predation, Predator-Prey

45. Which of these events would have an IMMEDIATE effect on primary productivity of this ecosystem; the extinction of toothed whales or the extinction of algae?

Extinction of Algae

They are the producers of this ecosystem.

Use the terrestrial food web below to answer questions 46 & 47



46. Indicate the organisms from the food web that belong to the trophic levels below.

Producers	Primary Consumers	Secondary Consumers	Decomposers
Grass	Rabbit Goat	Coyote Wolf	Fungus

47. In the 1940s wolves were heavily hunted by humans. This dramatically lowered their populations to 10% of their original size.

a) What would the direct effect of this change be on populations of *coyotes*?

It would increase due to less competition over rabbits as food.

b) What type of interaction did the *rabbit* and *coyote* have with one another?

Prey- Predator or Predation

c) Based on ONLY the relationship described in "b", what would happen to the *grass* population if the *coyote* population fell?

It would decrease; The rabbit population would increase due to less predation from coyotes, this would mean more rabbits eating more grass. Decreasing the grass population

d) What type of interaction did the *wolves* and *coyotes* have?

Competition over Rabbits as Food.

### Energy Flow

48. What makes the flow of energy in an ecosystem different than the flow of material/chemicals?

Energy is not recycled, it is lost to the environment.  
Energy is regained through solar energy/sunlight

49. Louise has determined that a section of forest in Québec receives 20 000J of energy from solar radiation within a specific period of time. The forest has a few species of trees and many smaller plant species as well. Several animals also call the forest home and with the plants they form a trophic network. Use this information to answer the following questions.

- a) How do the living organisms at the producer, consumer and decomposer levels obtain the energy they need to survive and grow?

Producer: Receives solar energy and transforms it into chemical energy by photosynthesis.

Consumer: Ingest producers or other consumers and digest them for chemical energy by respiration

Decomposer: Digest waste and detritus to produce chemical energy by respiration or fermentation.

- b) What happens to the 20 000J of solar energy as it is passed along the food chain?

Portions of it are lost as heat and the amount passed between levels goes down.

50. What happens to the organic matter in the ecosystem as it is passed along the food chain?

It is mostly conserved. Some becomes inorganic  $\text{CO}_2$  and is used by producers.

# The Technological World

## ***Mechanical Engineering Checklist***

1. Describe the characteristics of the links in a technical object (direct or indirect, rigid or flexible, removable or permanent, partial or complete)
2. Determine the desirable characteristics of links in the design of a technical object
3. Judge the choice of assembly solutions in a technical object
4. Define the typical functions (linking, guiding, sealing, lubricating)
5. Associate a typical function with certain parts of a technical object
6. Explain the choice of a type of link in a technical object
7. Explain the choice of a type of guiding control in a technical object
8. Explain the choice of a motion transmission system in a technical object (e.g. using a gear assembly rather than friction gears to get better engine torque and avoid slipping)
9. Explain the choice of a motion transformation system (screw gear system, cams, connecting rods, cranks, slides, rotating slider crank mechanisms, rack-and-pinion drive) in a technical object
10. Explain the choice of a motion transformation system in a technical object
11. Uses system that allow for speed changes in the design of technical objects

## ***Materials Science Checklist***

1. Describe the constraints to which different technical objects are subject: tension, compression, torsion, deflection, shearing (e.g. a diving board is subject to deflection)
2. Explain the choice of a material based on its properties.
3. Associate the use of different types of materials with their respective properties
  - Ferrous alloys** (cast iron is harder than steel)
  - Nonferrous metals and alloys** (the wire used in a dental appliance can be made of a nickel and titanium alloy, which has shape memory)
  - Wood and modified wood** (e.g. oak is used for flooring because it is a hard wood that is shock and wear resistant)
  - Plastics:** thermoplastics and thermosetting plastics (e.g. thermoplastics are used for prostheses because of their corrosion resistance and lightness; Bakelite, a thermosetting plastic, is used to mould electrical parts because it is a good electrical insulator)
  - Ceramics** (e.g. ceramics are used in ovens because they are very hard and heat and wear resistant)
  - Composites** (e.g. carbon fibre is used for hockey sticks because of its hardness, resilience and lightness)
4. Describe different treatments to prevent degradation of materials (e.g. metal plating, antirust treatments, painting)
5. Define heat treatments as ways of changing the properties of materials (e.g. quenching increases hardness but fragility as well)

### Links

51. List the 8 characteristics of linking components:

Direct	in - direct
Complete	Partial
Rigid	flexible
Removable	non - removable

52. What is the difference between a *direct* and an *indirect* link?

indirect links have intermediate linking components. Direct links do not.

53. What is the difference between a *complete* and a *partial* link?

Partially linked components can move independently. Completely linked parts cannot.

54. What is the difference between a *rigid* and a *flexible* link?

The connecting surfaces/components of a flexible link can be deformed. A rigid link cannot be.

55. What is the difference between a *removable* and a *non-removable* link?

Removably linked parts can be separated without damaging them. Non-removably linked parts are damaged if separated.

56. Use the characteristics of links to describe each example in this table.

Examples	Characteristics Applying to the Link
A screw holding together two pieces of wood.	<ul style="list-style-type: none"> <li>- Indirect</li> <li>- Rigid</li> <li>- Removable</li> <li>- Complete</li> </ul>
Two pieces of paper that have been glued together.	<ul style="list-style-type: none"> <li>- Indirect</li> <li>- Flexible</li> <li>- non-Removable</li> <li>- Complete</li> </ul>
The rivet that connects the two blades of scissors.	<ul style="list-style-type: none"> <li>- Indirect</li> <li>- Rigid</li> <li>- non-Removable</li> <li>- Partial</li> </ul>
A bicycle wheel and its tire.	<ul style="list-style-type: none"> <li>- Direct</li> <li>- Flexible</li> <li>- Removable</li> <li>- Complete</li> </ul>
Two metal parts joined by welding.	<ul style="list-style-type: none"> <li>- Direct</li> <li>- Rigid</li> <li>- non-removable</li> <li>- Complete</li> </ul>
A light bulb screwed into its light socket.	<ul style="list-style-type: none"> <li>- Direct</li> <li>- Rigid</li> <li>- Removable</li> <li>- Complete</li> </ul>
A nail that has been hammered into the wall.	<ul style="list-style-type: none"> <li>- Direct</li> <li>- Rigid</li> <li>- Removable</li> <li>- Complete</li> </ul>

57. Which characteristic of links means that the two linking components always move together and cannot move separately from one another?

Complete

58. Which characteristic of links indicates that the linked components cannot be removed without damaging them?

non-Removable

59. Which characteristic of links indicates that the two linked components are connected by an additional intermediate piece?

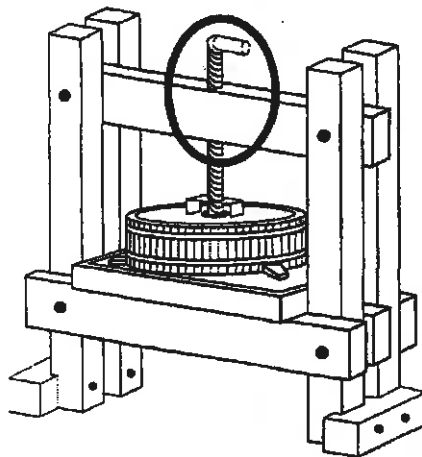
indirect

60. Which characteristic of links is used to describe a situation in which the connecting surface of the linked components cannot be deformed?

Rigid

Guiding Controls

61. A diagram of a cider press is shown below.



Identify the type of guiding control circled in the illustration above.

Helical



62. When a gear turns on an axle what type of guidance does the axle provide the gear?

Rotational

63. Trains are important vehicles for the transportation of materials and products across Canada. These include oil, natural gas, lumber and even consumer goods like furniture or electronics. Unlike planes, trucks, cars and boats; trains cannot be steered, they're guided by their rails. What type of guidance do train rails provide?

Translational

64. Indicate the type(s) of guidance for each of the examples in this table.

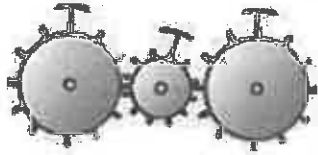
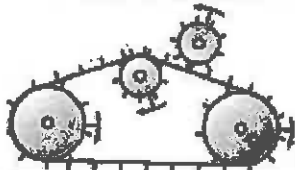
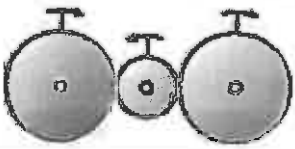
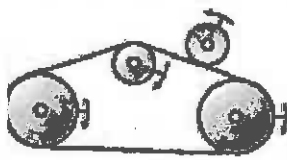
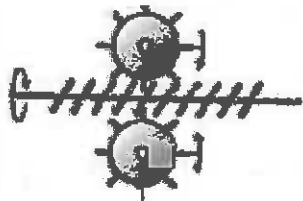
Example	Type(s) of Guidance
A drawer can be pulled out of a cabinet and pushed back in.	translational
A door that swings open or closed when pushed.	Rotational
A lid being screwed on or off of a jar or bottle.	Helical
A computer chair can spin and move up and down.	Rotational & Translational

65. An object can have translational and rotational guidance in a single part. However, if the two types of motion always occur together (movement is always both rotational and translational, such as in a screw-on lid) then the type of guidance has a special name. What is this called?

Helical

### Motion Transmission Systems

66. For each of the following motion transmission systems indicate the name of the system and whether or not it is reversible.

	Name of System	Reversible (Yes/No)
	Gear Train	Yes
	Chain, Sprocket	Yes
	Friction Gears	Yes
	Belt, Pulley	Yes
	Screw and Screw Gear	NO

67. What advantage does a gear train have over a set of friction gears?

Doesn't Slip, more efficient

68. Which transmission system can be found in guitars and harps and is typically used for slowing down rotational speed significantly?

Screw and Screw gear

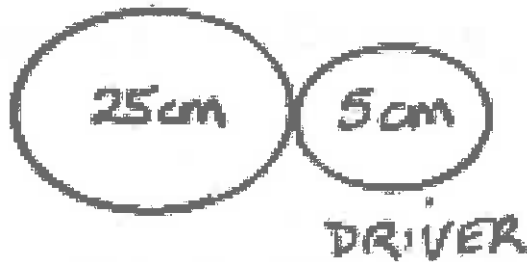
69. Two types of motion transmission systems are effective at transmitting motion over longer distances, what are they?

Belt and Pulley & Chain and Sprocket

70. Two types of transmission systems are prone to slipping, this reduces their efficiency.  
Which two system types can slip?

Friction Gears & Belt and Pulley

71.



- a) Does the *driven* gear rotate faster or slower than the *driver*?

Slower  $25 > 5$

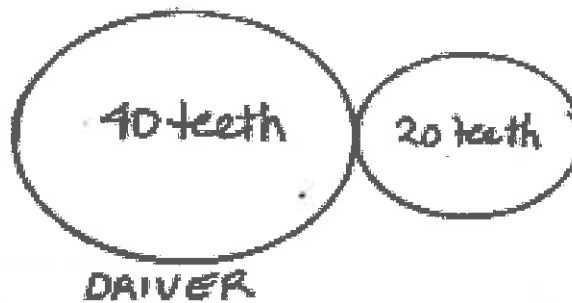
- b) What is the *gear ratio* for this system of gears?

$$\frac{\text{Driver}}{\text{Driven}} = \frac{5\text{cm}}{25\text{cm}} = \frac{1}{5}$$

- c) If the *driver* gear spins at 500rpm, how fast does the driven gear spin?

$$500\text{rpm} \times \frac{1}{5} = 100\text{rpm}$$

72.



- a) Does the *driven* gear rotate faster or slower than the *driver*?

Faster

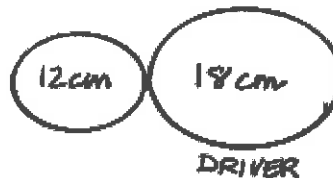
- b) What is the *gear ratio* for this system of gears?

$$\frac{\text{Driver}}{\text{Driven}} = \frac{40}{20} = 2$$

- c) If the *driver* gear spins at 200rpm, how fast does the driven gear spin?

$$200 \text{ rpm} \times 2 = 400 \text{ rpm}$$

73.



- a) Does the *driven* gear rotate faster or slower than the *driver*?

Faster

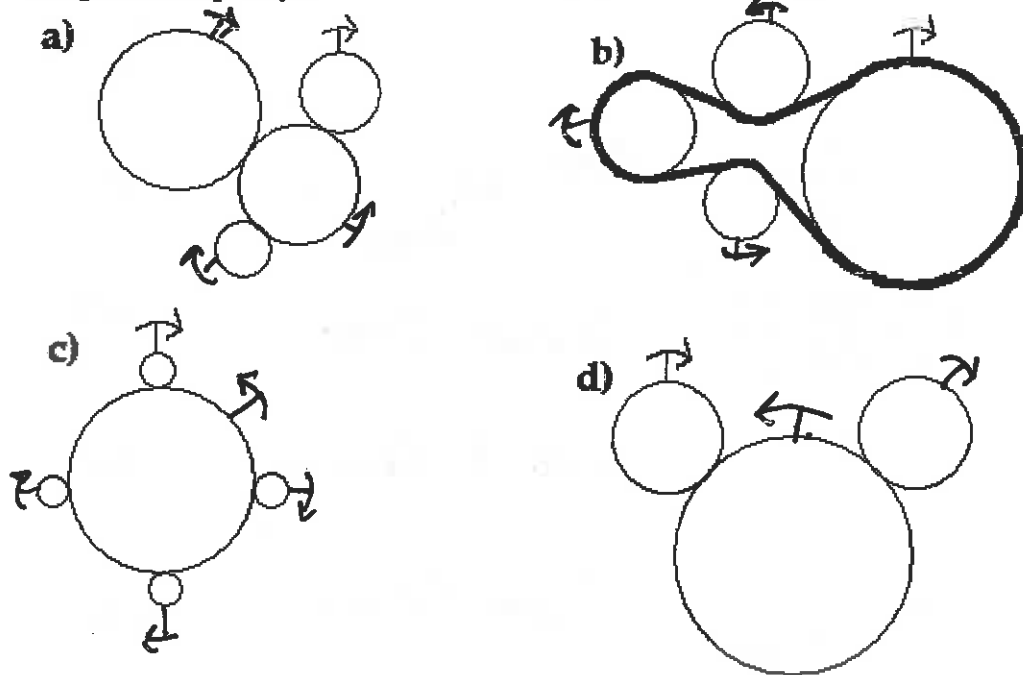
- b) What is the *gear ratio* for this system of gears?

$$\frac{\text{Driver}}{\text{Driven}} = \frac{18 \text{ cm}}{12 \text{ cm}} = \frac{3}{2}$$

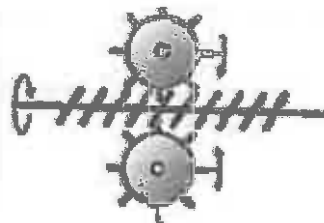
- c) If the *driver* gear spins at 200rpm, how fast does the driven gear spin?

$$200 \text{ rpm} \div \frac{3}{2} = 200 \text{ rpm} \times \frac{2}{3} = 133.33 \text{ rpm}$$

74. For each of the following images, label the missing directions of rotation for ALL of the gears and pulleys.



75. Gear trains and friction gear systems work similarly, as do chain & sprocket and belt & pulley systems. However, worm and worm-gear systems have no "sister" system. Answer the following questions to describe a worm & worm gear system.



a) This system is non-reversible, which component is ALWAYS the driver?

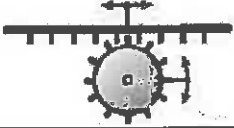


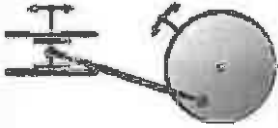
The worm / The Worm Screw

b) What happens to the driven components when the driver component makes one full turn?

The gears move one tooth over  
# of teeth turns

### Motion Transformation Systems

76. For the following table of motion transformation systems indicate the name of the system and whether or not the system is reversible.

	Name of System	Reversible (Yes/No)
	Rack and Pinion	yes
	Screw Gear	no
	Cam & Follower	no
	Slider Crank	yes

77. Fighting tops used to be a very popular children's toy in Japan and North America. The tops were launched by children pulling a long cord with teeth against a gear that would spin the top. Which motion transformation system is this an example of?

Rack and Pinion

78. In a car engine small explosions push the pistons downward. As the pistons slide down they act together to rotate a crankshaft which transmits rotational motion to the wheels. As the crankshaft turns it also pushes the pistons back up to their starting positions.

a) Is this an example of a reversible transformation system?

Yes it is

b) Which transformation system is represented by the pistons and crankshaft?

Slider Crank

79. Different kinds of wrenches use different screw-gear systems. However, both types of screw gear are non-reversible and perform the same transformation.

Which transformations can screw gear systems perform (circle one)?

Rotation → Translation

80. Cam and follower mechanisms can be found in some sewing machines and children's toys. They also play a very important role in controlling exhaust release in combustion engines like those in cars.

Which transformations can a cam and follower perform (circle one)?

Rotation → Translation

81. Cam and follower systems require that one of their components receive translational guidance.

Which component is guided this way?

The follower or "Pin"

82. A reversible transmission or transformation system is not one that can turn clockwise or/and counter-clockwise. What does reversibility mean in this context?




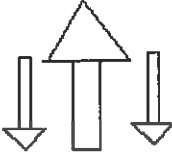

The driver and driven components  
can switch roles.

83. What does it mean if a component is described as a driven component?

It receives motion/mechanical energy  
from another moving part.

Materials Science

84. Identify the five major constraints using their symbols and describe what each constraint means in a materials science context.

Constraint	Symbol	Description
Compression		Crushing, squeezing
Tension		Pulling or stretching
Torsion		Twisting or Turning
Deflection		Bending or folding or Bowing
Shearing		Cutting or tearing

85. Suspension bridges are subject to many different constraints. Huge steel cables are pulled tight to hold the majority of the bridge's weight while heavy winds can twist the roadway causing damage that could eventually trigger a collapse. Those same winds also cause the bridge to bend and sometimes break.

What are the three constraints that suspension bridges must endure?

Torsion , Tension , Deflection




86. The ceratopsian dinosaurs, like triceratops, are theorised to have had teeth that cut past each other like the blades of scissors. They may have used these to bite through trees.

What kind of constraint would this sort of bite cause (Hint: not Compression)

Shearing



87. Indicate which constraint is demonstrated by each of the following examples.

	Situation	Constraint
A)	Two groups of children playing Tug-O-War	Tension
B)		Torsion
C)	A towel being wrung dry	Torsion
D)		Deflection
E)	A piece of paper being torn up	Shearing
F)		Compression

88. What are the 6 mechanical properties that an object or material can have and what does each property mean?

Mechanical Property	Definition
Hardness	Ability to resist scratches and dents
Stiffness	Ability to maintain shape when constrained
Resilience	Ability to resist shock/sudden constraint without breaking
Elasticity	Ability to be <del>stretched</del> without breaking <sup>deformed</sup> and Return to normal
Malleability	Ability to be bent or flattened without breaking
Ductility	Ability to be stretched without Breaking

89. What are the three non-mechanical material properties and what are their definitions?

Property	Definition
Electrical Conductivity	Ability to transmit an electrical current through the material
Thermal Conductivity	Ability to transmit heat energy through the material
Corrosion Resistance	Resistance to acids, bases, Oxidation and other chemical damage

90. Petri is ordering a set of dishes for his kitchen. He wants to be able to handle them without burning himself and also doesn't want the dishes to corrode or scratch easily. What material should Petri's dishes be made of?

Ceramic — High Hardness  
 — Low thermal Conductivity.

91. Wood is an extremely common building material in Canada due to its abundance and versatility. Answer the following questions about this material.

- a) Wood is often used to build furniture because it can bend or deform slightly under a compressive or deflective constraint and return to its original shape once the constraint is removed. **Which mechanical property does this represent?**

Elasticity

- b) Materials like porcelain, glass and even stone can shatter if their temperature changes quickly or if they're struck very hard. Wood does not break easily in this way. **Which mechanical property of wood does this describe?**

Resilience

- c) Torches tended to be made of an oil soaked cloth wrapped around one end of a wooden branch or stick. The cloth would then be set on fire to provide light. However, the person holding the opposite end of the torch would not be burned or feel the heat of the fire. Modern matches work in much the same way. **Which property of wood does this example represent?**

Low Thermal Conductivity

- d) One of the weaknesses of wood as a building material is that it's easily scratched, students sometimes vandalise wooden desks or shelves by scratching into them with scissors. **Which property does this show that wood does NOT have?**

Hardness

92. Metals and combinations of metals (called alloys) are incredibly versatile materials. The properties of a metal or alloy can vary depending on the exact type of metal, steel and gold for example. However all metals share many characteristics with one another.

- a) Almost all electrical wires are made out of a metal of some kind. While some metals are better for this purpose than others, metals in general are a good material for making electrical wires.

**What are the two properties of metals that make them a good material for electrical wires?**

Ductility

High electrical  
Conductivity

- b) Machinery is often made up of metal parts; from bicycles all the way up to giant assembly lines and construction vehicles. The many moving metal parts are subjected to a lot of friction and abrasion but they do not scratch or get damaged easily.

**Which mechanical property of metals does this demonstrate?**

Hardness

- c) Cast iron cookware is popular among home and professional cooks due to its ability to heat food very evenly as the heat is transferred from the stove surface throughout the pan or pot.

**Which property of metal does this effect demonstrate?**

High Thermal Conductivity

- d) Acids are known to react with most metals, changing them chemically and producing flammable hydrogen gas.

**Which property does this demonstrate metals NOT having?**

Corrosion Resistance

93. Thermoplastics and thermosetting plastics are very modern materials; they've been used by humans for less than 400 years compared to the thousands of years of history behind wood, ceramics and metals.

- a) Thermoplastics are a cheap and recyclable material that can be molded into many shapes. Thermosetting plastics are less easily recycled as once they have set into a shape they cannot be re-moulded like thermoplastics. However, thermosetting plastics are very resistant to scratches and breaks caused by physical shock.

**Which two mechanical properties do thermosetting plastics have that differentiates them from thermoplastics?**

Hardness	Resilience
----------	------------

- b) Rubber is a type of thermosetting plastic that can be flattened or bent without breaking. Most types of rubber also return to their original shapes after being deformed in one of the ways mentioned above.

**Which two mechanical properties does rubber, a thermosetting plastic, have based on the description above?**

Malleability	Elasticity
--------------	------------

- c) Most plastics are deformed easily; they do not maintain their shapes when subjected to constraints.

**Which mechanical property do plastics tend NOT to have?**

Stiffness
-----------

- d) Plastics are often used to coat electric wires and prevent electric shocks. This is something that plastics are well suited for because of one of their non-mechanical properties.

**Which non mechanical property makes plastics a good choice for coating wires?**

Low electrical conductivity
-----------------------------

94. Ceramics are a group of materials made by heating and cooling certain minerals. Glass and porcelain are both examples of ceramics.

- a) Ceramics are incredibly resistant to scratching; some can even resist being scratched by metals. These makes ceramics useful for making tools and devices that need to stand up to a lot of abrasion like knife blades or brake discs for cars.

**What is the mechanical property shared by most ceramics that allows them to resist damage by scratching and abrasion?**

Hardness

- b) Ceramics cannot be stretched, bent or flattened without breaking. If a constraint is strong enough to change the shape of a ceramic the ceramic will fracture.

**Which two mechanical properties do ceramics NOT have, based on this data?**

Ductility

Malleability

- c) Ceramic pottery has been used throughout history by many different civilizations to keep food and drinks at stable temperatures. A ceramic pot does not transmit heat easily between its interior and exterior.

**Which non-mechanical property does this suggest ceramics possess?**

Low Thermal Conductivity

- d) Strong acids such as hydrofluoric acid (HF) can cause damage to ceramics (like glass). For this reason, chemists need to coat the insides of glass test tubes with special protective coatings when handling hydrofluoric acid.

**Which non-mechanical property does this suggests ceramics do not have?**

Corrosion Resistance

95. Composite materials are composed of at least two different materials. This can be done to mix the advantages and disadvantages of those materials together for a special purpose. The choice of materials and how they are combined determines the properties of a composite.

- a) One of the two materials in a composite serves as the overall framework that shapes the object being made and provides the majority of the structure of the design.

**What is the name for the material that fulfills this role in a composite?**

Matrix

- b) The other material is added to strengthen the first material. It effectively plays a supporting role and is used because it improves the weaknesses of the first material or magnifies the advantages of the first material.

**What is the name for the material that fulfills this role in a composite?**

Reinforcement

- c) A composite baseball bat can be made to be as strong as a wooden bat by combining carbon fibre with plastic resin. However the composite bat is much lighter than the wooden one.

**What advantage does this grant the batter?**

The bat can be swung faster.

- e) In the early days of aircraft the wings were made out of wood. However these early planes were vulnerable to lightning strikes which would set them on fire. Modern aircraft use composite wings made of carbon fibre and aluminum webbing.

**What property of the composite makes these wings more durable in the face of being struck by lightning?**

The aluminum conducts electricity through the wings without starting fires.

96. All materials have limits under which they deform or break in some way. For some these limits are higher than other.

What are the three types of deformation and what does each one mean?

Deformation Type	Definition
Plastic	Permanent change in shape
Elastic	Temporary change in shape
Fracture	Break, crack, shattering, irreparable

97. A student-teacher sits on a desk and it bends under their weight. When the student-teacher stands up the desk springs back to its original shape.

a) What type of constraint was applied by the student-teacher to the desk?

Deflection

b) What type of deformation did the desk undergo in this example?

Elastic

98. Two fencers at a competition engage in a match but after a few parries and blocks one of them has their foil (a fencing sword) break in half.

What type of deformation does this situation represent?

Fracture

99. On the first snowfall of the year a small accident occurs in Ste-Anne-de-Bellevue. One car is undamaged but the other car has a severely bent and dented bumper.

What type of deformation occurred in the car's bumper?

Plastic



100. When a baseball batter shatters a bat against a pitch **what kind of deformation has occurred in the bat?**

Fracture

101. When an archer draws back an arrow on their bow the wooden limbs bend toward one another. When the archer releases the limbs spring back to their original positions propelling the arrow towards the target.

**What type of deformation do the limbs of the bow undergo in this example?**

Elastic

102. Paper folding (also called origami) is an art form that has received attention for both aesthetic and scientific reasons. When paper is folded it keeps its new shape and doesn't return to the way it was before.

**What type of deformation is origami (paper folding)?**

Plastic

103. **What does the degradation of a material mean?**

The material is exposed to the environment or constraints that cause it to lose its properties.

104. **What is the purpose in protecting a material?**

Protection slows down or prevents degradation.

105. What can be done to wood to prevent it from decomposing?

- Heat or chemical treatment
- Varnishing or Painting

106. What are two ways to protect metal against rust?

- Plating with another metal
- Painting

107. The quench hardening process is used to improve the hardness of steel but decreasing its resilience. What are the steps of the quench hardening process?

- Steel is Heated to very high temperature
- Steel is rapidly cooled

108. Tempering is a process that typically follows quench hardening; it restores resilience at the cost of some of the hardness gained by quenching.

What is done to the steel to temper it?

- Steel is reheated but to a lower temperature than during the Quench-hardening process.

109. When steel is deformed plastically it is simultaneously degraded. Reversing the degradation of steel can be done through a special heat treatment.

What is this treatment called?

annealing

## **The Material World**

### ***Static Electricity Checklist***

1. Associate elementary particles with their electrical charge
2. Describe the behaviour of electrical charges of opposite/like signs when close together
3. Describe static electricity as the transfer of electrons from one body to another

### ***Dynamic Electricity Checklist***

4. Describe qualitatively the relationship between voltage, resistance and current intensity in an electrical circuit
5. Apply the mathematical relationship between voltage, resistance and current intensity in an electrical circuit ( $V = RI$ )
6. Describe the function of different elements of an electrical circuit (e.g. the wires transmit electrons along the circuit, resistors transform electrical energy into another form of energy)
7. Describe the two types of connections in electrical circuits (series, parallel)
8. Distinguish between alternating and direct current
9. Represent a simple electrical circuit using a diagram
10. Apply the mathematical relationship between power, voltage and current intensity in an electrical circuit ( $P = VI$ )
11. Describe qualitatively the relationship between the power of an electrical appliance, the electrical energy it consumes and the amount of time it is in operation
12. Apply the mathematical relationship between electrical energy consumed, the power of an electrical appliance and the amount of time it is in operation ( $E = P\Delta t$ )

### ***Electromagnetism Checklist***

13. Describe the magnetic field produced by a current-carrying wire (right-hand rule)
14. Name ways of modifying the intensity of the magnetic field produced by a current-carrying wire
15. Compare the behaviour of a compass in the magnetic field of a magnet with the magnetic field created by a current-carrying wire.

## **The Technological World**

### ***Electrical Engineering Checklist***

16. Define power supply as the ability to generate electrical current
17. Determine the source of current in technical objects with an electrical circuit (e.g. chemical battery, solar cell, alternator, thermocouple, piezoelectric)
18. Conduction, insulation and protection
19. Define conduction as the ability to conduct electricity
20. Distinguish between electrical conductors and insulators in a technical object
21. Describe the role of a protective device in a circuit (fuse, breaker)
22. Analyze the factors that affect electrical conductivity (section, length, nature, temperature of conductor)
23. Define control as the ability to control the travel of electrical current
24. Describe different types of switches (lever, pushbutton, flip-flop, magnetic control)
25. Associate the transformation of energy with different components of a circuit
26. Describe the energy transformations that take place in electrical or electronic appliances
27. Defines the energy efficiency of a device or system as the proportion of energy consumed that is transformed into effective work
28. Explains how to improve the energy efficiency of an electrical appliance

Static Electricity

110. Which sub-atomic particle is negatively charged and mobile?

Electron

111. Which atomic particle is positively charged and immobile?

Proton

112. Determine the net charge on each of these atoms, be sure to state the sign and the magnitude (numerical value) of the net charge.

a) An atom containing 80 protons and 84 electrons

-4

b) An atom containing 1 proton and 0 electrons

+1

c) An atom containing 7 protons and 10 electrons

-3

d) An atom containing 11 protons and 10 electrons

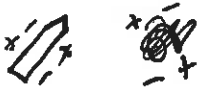


+1

e) An atom containing 10 protons and 10 electrons

Neutral "0"

113. An ebonite rubbed on a piece of fur becomes negatively-charged.

Draw a diagram to show the transfer of charges when the ebonite rod is in contact with the fur.

Before Rubbing	During Rubbing	After Rubbing
		
Explanation: Both objects neutrally charged	Explanation: Electrons transfer from fur to ebonite by friction	Explanation: ebonite has more $e^-$ neg-charge fur has less $e^-$ than protons "pos" charge

114. When two objects are rubbed together one will become positively charged and the other will become negatively charged.

What is happening between the two objects to cause them to be charged? (You may explain and use pictures)

Electrons are transferred from one object to the other by friction.  
The object that gains electrons is negatively charged. The object that loses electrons becomes positively charged.

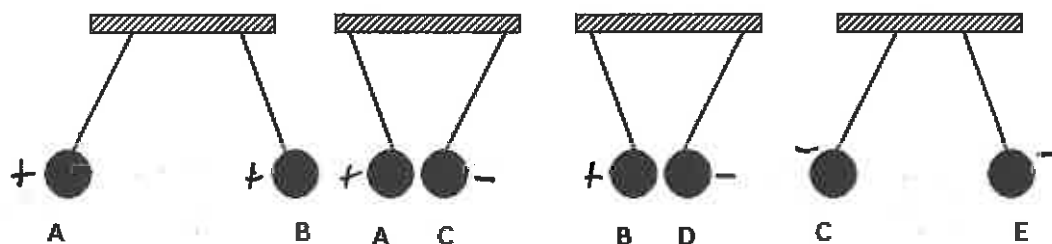
115. When two charged objects with the same sign come together what type of force occurs between them?

Repulsion

116. When two charged objects with opposite signs come together what type of force occurs between them?

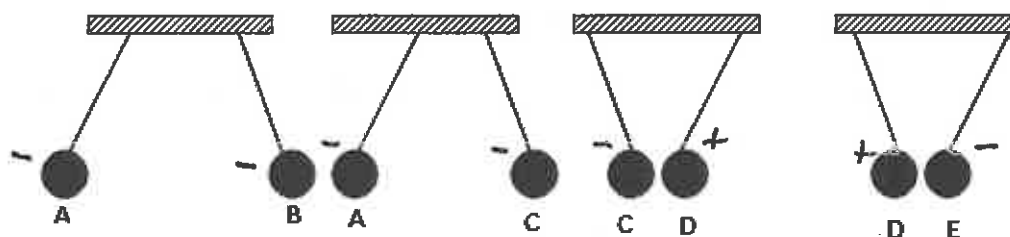
attraction

117. Five electrically charged spheres are set up to hang in pairs. If sphere A carries a positive charge what are the charges of the other spheres?



Sphere	Charge
<b>B</b>	+
<b>C</b>	-
<b>D</b>	-
<b>E</b>	-

118. Five electrically charged spheres are set up to hang in pairs. If sphere A carries a negative charge what are the charges of the other spheres?



Sphere	Charge
<b>B</b>	-
<b>C</b>	-
<b>D</b>	+
<b>E</b>	-

119. At a child's birthday party a balloon is rubbed on a friendly clown's hair and then stuck to a nearby wall.

a) What happens when the balloon is being rubbed against the clown's hair?

Electrons transfer from the hair to the balloon  
Hair loses electrons  $\rightarrow$  Hair is positively charged  
Balloon gains electrons  $\rightarrow$  Balloon negatively charged

b) What charge does the balloon have after it's rubbed on the clown's hair?

Negative

c) What charge does the clown's hair have after the balloon is rubbed across it?

Positive

d) What happens when the balloon is brought to the wall that allows it to stick?

The negatively charged balloon repels the electrons in the wall. This results in an induced positive charge on the wall which attracts the negatively charged balloon

120. What is charging by conduction?

When charges move between objects that are touching but not rubbing.

121. What is charging by induction?

When an object is charged by another charged object being nearby. The objects do not touch.

122. If an ebonite rod is rubbed on wool the rod becomes negatively charged. If a gold rod is also rubbed by wool it will also become negatively charged.

What would happen if the two rods (ebonite and gold) were then brought together?

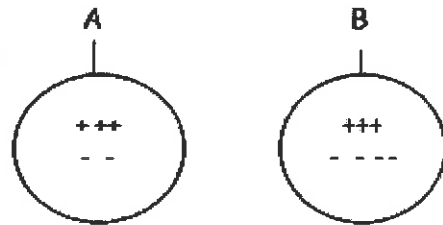
They Repel one another

123. The charged spheres, A and B, are suspended from a wire.

a) What is the polarity (charge) of each sphere?

Sphere A : + /

Sphere B: - /



b) Would the spheres attract or repel?

attract, opposites attract

#### Conductivity

124. If Marc wants to set up a bright holiday light show this winter should he use steel or copper wires to connect his lights?

Copper

125. Sian wants to repair some damaged wiring for the light in her snake's terrarium. She has the option of buying wire with a diameter of 3mm and wire with a diameter of 5mm. If she wants the circuit to be efficient which wire should Sian use?

The 5mm wire



126. Manminder is setting up an electric mobile in her daughter's crib. She wants the system to have good conductivity since the batteries are difficult to change (they're tightly sealed up to keep them away from the baby). She cannot change the temperature in the room because her daughter would be uncomfortable.

**What are Manminder's options for improving conductivity if she cannot change the temperature?**

Using Thicker wiring, Copper wiring and shorter circuits.

127. One of your friends is claiming that their electronics work much better once they have heated up. They claim that the electric parts work better when they are hot.

**What could you explain to your friend to correct their misconception?**

Electrical conductivity is lower at high temperatures. Materials are more conductive when cool.

128. We were considering setting up more fans in the classroom to make it more comfortable on hot days in May, June and September. **Would it be more efficient to use 80m long extension cords or 10m long extension cords for each fan? Explain your choice.**

10m, the shorter cords would have better conductivity and waste less energy.

Ohm's Law "V=IR"

129. What do the letters V, I and R represent in Ohm's Law?

V = Potential Difference or Voltage  
I = Current Intensity      R = Resistance

130. What happens to the current intensity in a circuit if the voltage is increased and resistance is unchanged?

The current increases

131. What happens to the resistance in a circuit if the voltage is decreased but the current stays the same?

The resistance has decreased

132. What happens to the voltage in a circuit if the resistance and current both increase?

The voltage also increases

133. What is the mathematical relationship between *potential difference* and *current intensity*?

Direct Proportionality

134. What is the mathematical relationship between *potential difference* and *resistance*?

Direct Proportionality

135. What is the mathematical relationship between *current intensity* and *resistance*?

inverse proportionality

136. A flashlight has a power source of 3.0 V and operates with a current of 0.20 A.

What is the resistance in the circuit?

$$R = \frac{V}{I} = \frac{3V}{0.2A} = 15\Omega$$

137. A circuit has a resistance of  $27\Omega$  and draws a current of 4.4 A.

What is the voltage in the circuit?

$$V = IR = 27\Omega \times 4.4A = 118.8V$$

138. An MP3 player uses a current of 2.0 A and has an internal resistance of  $3.0\Omega$ .

How many 1.5V batteries are required?

$$V = IR = 2A \times 3\Omega = 6V \quad ; \quad \frac{6}{1.5} = 4 \quad 4 \text{ batteries of } 1.5V$$

139. Your younger brother's computer game console does not work anymore. You decide to open it up to fix it and notice that the resistor must be replaced. You know that when the console operates with a 9-V battery, the current intensity is 1.2 A.

What is the value of the resistor to be replaced?

$$\frac{V}{I} = R = \frac{9V}{1.2A} = 7.5\Omega$$

140. Apples are best stored at  $0^{\circ}\text{C}$  with 90% relative humidity and some air circulation. Warmer temperatures will cause apples to age faster and low humidity can cause excessive shriveling. Some apple orchards have refrigerated sheds to store apples that will be distributed at a later date. The refrigeration unit runs on a 240 V generator and requires a current of 15 A. **Determine the resistance of the refrigeration unit.**

$$R = \frac{V}{I} = \frac{240\text{V}}{15\text{A}} = 16\Omega$$

141. Christine is an oceanographer studying the chemical composition of the ocean floor of the coast of Baffin Island. When her deep water robot surveyor breaks down she discovers that the resistors in its circuitry have fallen out. The robot's power supply provides 80V of potential difference and the robot draws 500mA of current to function. **What is the resistance value of the resistors that Christine must replace?**

$$R = \frac{V}{I}$$

$500\text{mA} = 0.5\text{A}$   
 $\div 1000$

$$R = \frac{80\text{V}}{0.5\text{A}} = \underline{160\Omega}$$

142. A giant strobe light for a music concert has burnt out and must be replaced. The roadies, however, forgot to check what kind of bulb they needed before throwing the burnt one into the trash. They do know that the light used a 300V power supply and that the current in the circuit was 1.5A. The roadies can test the resistance of bulbs in the shop to figure out which one is appropriate for the strobe light. **What is the resistance of the correct bulb for the light?**

$$R = \frac{V}{I} = \frac{300\text{V}}{1.5\text{A}} = 200\Omega$$

143. At the same concert one of the speakers becomes unplugged. In the dark the roadies can't tell which power supply it paired with. The sound technician informs them that the resistance of the speaker is  $600\Omega$  and that it needs  $400\text{mA}$  to function properly. What would the voltage of the power supply need to be to make the speaker work?

$$400\text{mA} = 0.4\text{A}$$

$\div 1000$

$$V = IR = 0.4\text{A} \times 600\Omega = \underline{240\text{V}}$$

### Power and Energy

Relationship between power and electrical energy

$$\begin{array}{c} P \\ I/V \end{array}$$

$$E = P\Delta t$$

$$P = VI$$

$$\begin{array}{c} E \\ P/t \end{array}$$

144. Describe the relationship between power and energy based on the equation above.

Power is energy per unit of time

Power represents a rate of energy production or use.

145. We use two different units to describe energy, what are they?

Joules (J)

Watt-hours (W·h)  
kilowatt-hours (kW·h)

146. What is the difference between a watt (W) and a kilowatt hour (kW h)?

A watt (W) is a measure of power  
while a kilowatt hour (kW·h) is a unit of energy

147. If I leave a 40W light bulb on for 7 hours how much energy will it use in kW h?

$$40\text{W} = 0.04\text{kW}$$

$$E = P \times \Delta t = 0.04\text{kW} \times 7\text{h} = 0.28\text{kW}\cdot\text{h}$$

148. The classroom is lit by 12 pairs of fluorescent lighting tubes. Each tube has a power rating of 79W. Electricity costs an average of 7.5¢ per kW h. The classroom lights are turned on for 6 hours every school day.

What is the cost of lighting the classroom for a week?

$12 \text{ pairs} = 24 \text{ tubes}$ $\text{Total Power} = 79\text{W} \times 24 = 1896\text{W}$ $\text{Total Time} = \frac{6\text{hr}}{1\text{day}} \times \frac{5\text{days}}{1\text{week}} = 30\text{hours in a week}$	$E = P \times t \quad \text{Energy}$ $= 1.896\text{kW} \times 30\text{h}$ $= 56.88\text{kW}\cdot\text{h}$ $\text{Cost} = E \times \text{Rate}$ $= 56.88\text{kW}\cdot\text{h} \times 0.075\text{¢ per kW}\cdot\text{h}$ $\text{Cost} = \$4.27$
---	--

149. Amelia's toaster has a power rating of 970W; making toast the way she likes it takes this model of toaster 2.5 minutes.

a) What amount of energy does the toaster consume in that time? (Answer in joules)

$\text{Joules} = W \times \text{sec}$ $2.5\text{min} = 150\text{sec}$ $\quad \quad \quad \times 60$	$E = P \times t$ $= 970\text{W} \times 150\text{sec}$ $E = 145,500\text{ J}$
---	--

b) What amount of energy (kW h) would the toaster consume in 4 weeks if Amelia makes toast 5 times a week?

$\frac{5\text{ days}}{\text{week}} \times 4\text{ weeks} = 20\text{ days}$ $20\text{ days} \times \frac{2.5\text{min}}{\text{day}} = 50\text{min}$ $50\text{min} = 0.83\text{h}$ $\quad \quad \quad \div 60$	$970\text{W} = 0.97\text{kW}$ $\quad \quad \quad \div 1000$ $E = P \times t$ $= 0.97\text{kW} \times 0.83\text{h}$ $= 0.81\text{kW}\cdot\text{h}$
--	---

150. The local bakery uses two different ovens to bake fresh blueberry pies;

**Oven A:** The oven is connected to a 220 V wall outlet that draws a current of 14 A. It took 1 hour to bake the pies in Oven A

**Oven B:** It took 2 hours to bake the pies in a 2400 W oven.

The bakery would like to consume less energy to both save on costs and be more environmentally friendly.

**Which oven should the bakery use to reduce their energy consumption?**

$E = P \times T$ $P = V \times I$ $A) P = 220V \times 14A$ $= 3080W$ $E = 3.08kW \times 1h$ $= 3.08kW \cdot h$	$B) E = 2.4kW \times 2h$ $= 4.8kW \cdot h$  Oven A uses less energy
--	---

151. Heating a building in the Canadian winter can be very expensive. A Holiday Inn up north near Chicoutimi is trying to decide between two heating systems.

**Baseboard heaters** would draw 16 A of current at 175V. They will need to be on for 14 hours a day during the winter to maintain comfortable temperatures.

The same number of **space heaters** would have a power rating of 4000W and be on for 8 hours a day during the winter to produce the same results.

**Which heating system would use less energy over the course of the winter?**

<b>Baseboard</b> $P = 16A \times 175V$ $= 2800W \div 1000$ $= 2.8kW$ $E = 2.8kW \times 14h$ $= 39.2kW \cdot h$	<b>Space</b> $E = 4000W \times 8h$ or $E = 4kW \times 8h$ $= 32kW \cdot h$ The space heaters would use less energy.
---	---

152. A halogen light bulb releases 72 kJ of light energy in a 1 hour period. If the bulb also consumes 288,000 J of electrical energy in that time, **what is the efficiency of the bulb?**

$$\begin{aligned}\text{Efficiency} &= \frac{\text{Useful E}}{\text{Consumed E}} \times 100\% \\ &= \frac{72 \text{ kJ}}{288 \text{ kJ}} \times 100\% = 25\% \text{ efficiency}\end{aligned}$$

153. Driving an electric car to school and back represents 40 million joules of useful mechanical energy. If the electric motor is 65% efficient, **what amount of energy must be stored in the car's batteries for it to be able to make this trip without charging?**

$$\begin{aligned}\text{Consumed E} &= \frac{\text{Useful E}}{\text{Efficiency}} \times 100\% \\ &= \frac{40\,000\,000 \text{ J}}{65\%} \times 100\% = 61\,540\,000 \text{ J}\end{aligned}$$

Approx: 61.54 million joules

154. Peyara is installing a new heater in her office. The heater has a power rating of 500W and she intends to have it running for 20 hours each day. The heater is listed as being 80% efficient at transforming electricity into heat. **What amount of heat energy will Peyara's new heater produce each day?**

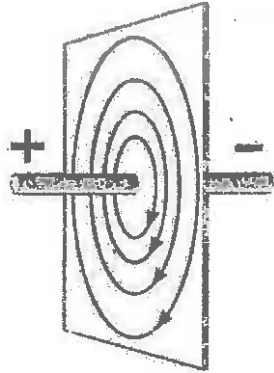
$$\begin{aligned}E &= P \times t & 500 \text{ W} &= 0.5 \text{ kW} \\ E &= 0.5 \text{ kW} \times 20 \text{ h} & & \div 1000 \\ &= 10 \text{ kW}\cdot\text{h} \\ \text{Useful E} &= \frac{\text{Efficiency} \times \text{Consumed E}}{100\%} = \frac{80\% \times 10 \text{ kW}\cdot\text{h}}{100\%} \\ \text{Useful E} &= 8 \text{ kW}\cdot\text{h}\end{aligned}$$



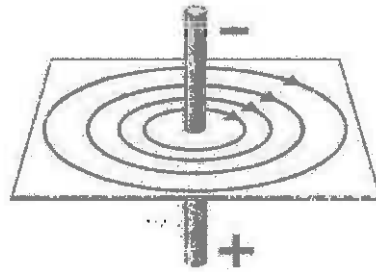
### Electromagnetism

155. Which of the illustrations below is an accurate representation of the magnetic field of a live wire? Explain your answer.

a)

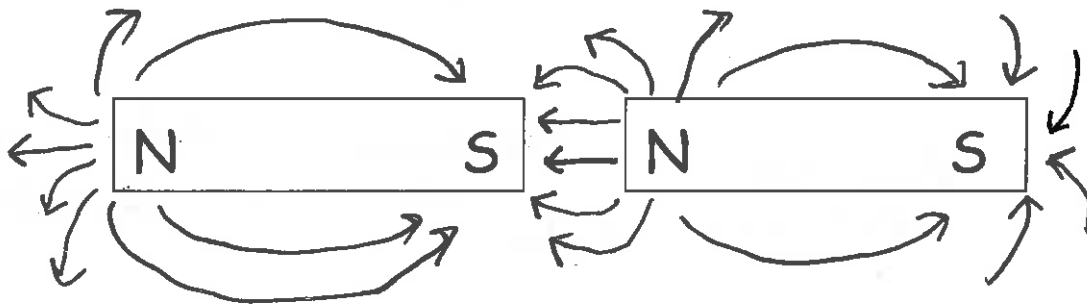


b)



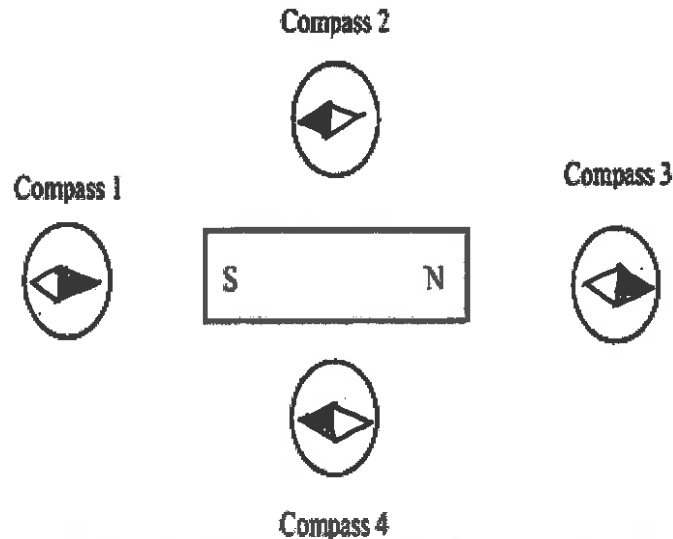
A) This field representation matches the right-hand rule. If the right thumb points to the negative direction the fingers point to the field direction.

156. Draw the direction of the magnetic field around the magnets and determine if an attraction or repulsion will occur.

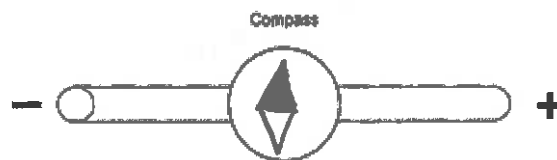


Attraction

157. The following diagram shows a bar magnet and four compasses. **Draw the compass needles pointing in the appropriate direction based on the magnetic field of the magnet.**



158. Below is a diagram of a live wire. **Indicate which direction the compass needle will point based on its position and the current flow in the wire.**



159. What three things can be done to increase the magnetic field strength of an electromagnet or solenoid?

More turns of the wire	Ferromagnetic Core ex. Iron	Higher Current Intensity
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### Electrical Engineering

160. Certain substances (conductors) allow electricity to travel through them, while others (insulators) do not allow electricity to travel through them.

For each substance listed below, identify it as a conductor (C) or an insulator (I).

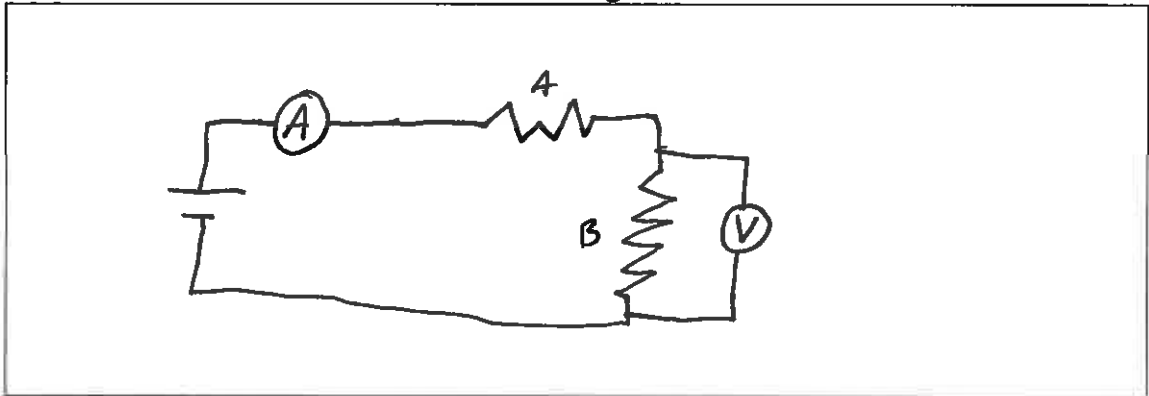
Material	Conductor or Insulator
Silver	C
Wood	I
Rubber	I
Copper	C
Paper	I
Steel	C

161. What is the electrical function of the following components in a circuit?

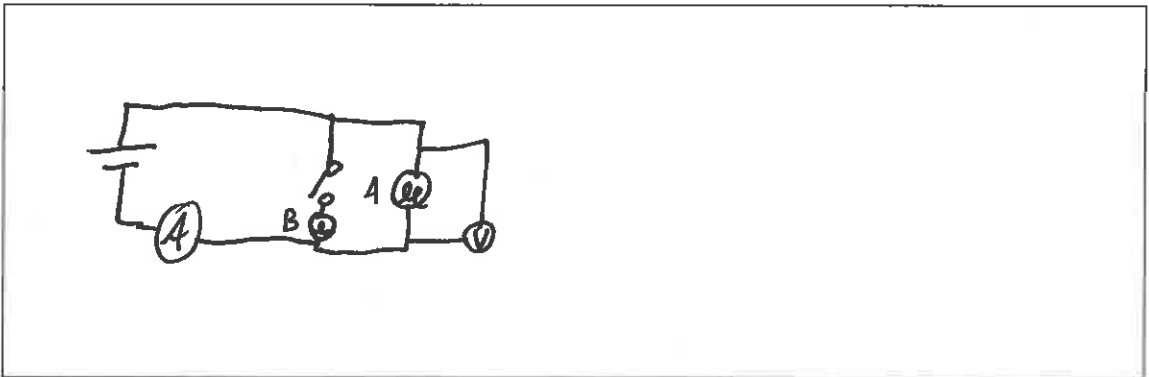
Component	Function
Wire	Transmit and Conduct electricity
Light bulb	Transform energy elec $\rightarrow$ light
Battery	Power Source
Generator	Power Source
Heating element	Transform energy elec $\rightarrow$ heat
Door bell	transform energy elec $\rightarrow$ sound
Breaker	Protection
Push-button switch	Control
Fuse	Protection
Plastic coating a wire	Insulation
A lever switch	Control
A fan motor	Transform energy elec $\rightarrow$ mechanical

162. Draw a circuit diagram to represent each of the situations described.

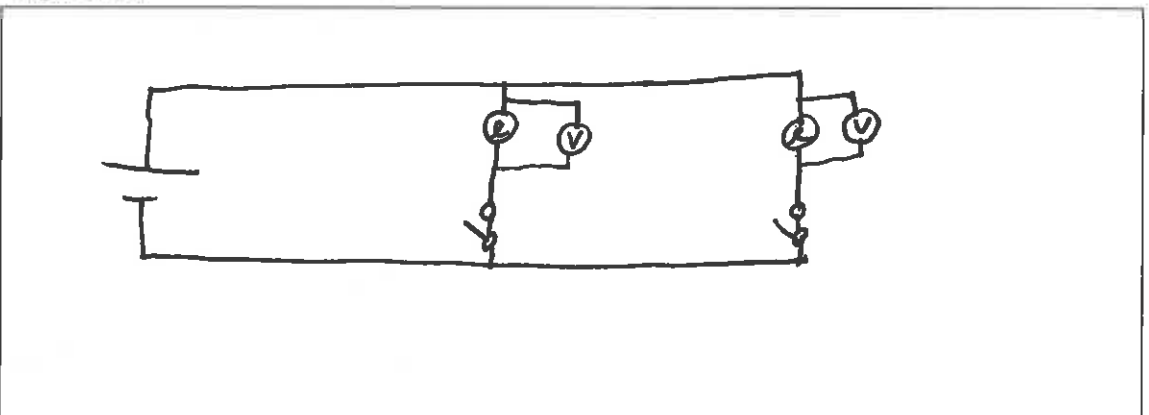
- a) a power supply, two resistors (A and B) in series, an ammeter to measure the current in the circuit and a voltmeter to measure the voltage across resistor B.



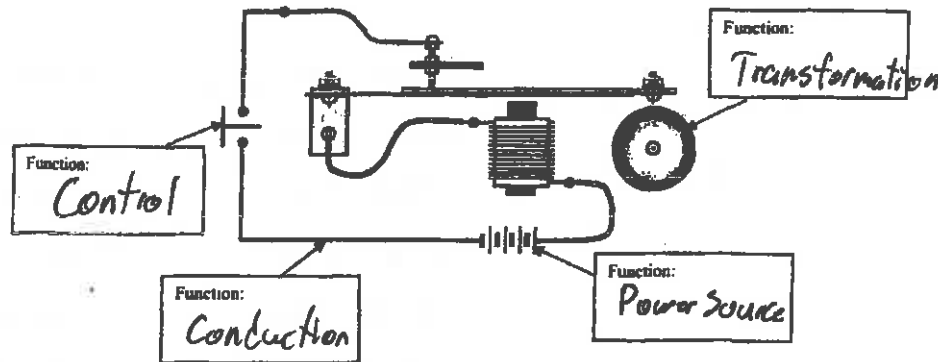
- b) a power supply, two light bulbs (A and B) in parallel, a switch that will turn off light bulb B, an ammeter to measure the current in the entire circuit and a voltmeter to measure potential difference across light bulb A.



- c) a power supply, two light bulbs connected in parallel, two switches, one that controls each light bulb and two voltmeters one measuring the potential difference across each light bulb.



163. Refer to the diagram of a doorbell and indicate the four electrical functions in the boxes provided.



164. Give two examples of protective devices.

Breaker	Fuse
---------	------

165. What four factors affect the electrical conductivity of a wire?

Temperature	Thickness
Material	Length

166. What is the function of a switch?

To control the circuit
------------------------

167. Draw a simple circuit with 2 resistors and a power supply in series and in parallel.

<p>Series</p>	<p>Parallel</p>
---------------	-----------------

168. The components of a circuit that transform energy are called *transducers*. For the following list of transducers, indicate which energy transformation they perform.

Transducer	Transformation
An Electric Lamp	Electricity → Luminous
A Photovoltaic Cell (Solar Panel)	Luminous → electricity
A Coal-Fired Generator	Chemical → electrical
An Oven	electrical → Heat
A Blender	electrical → mechanical
A Tidal Turbine	mechanical → electrical
A Water Heater	electrical → thermal

169. The diameter of the wire in an electrical circuit is *increased*.

a) What will happen to the resistance of the circuit?

it decreases

b) What will happen to the conductivity of the circuit?

it increases

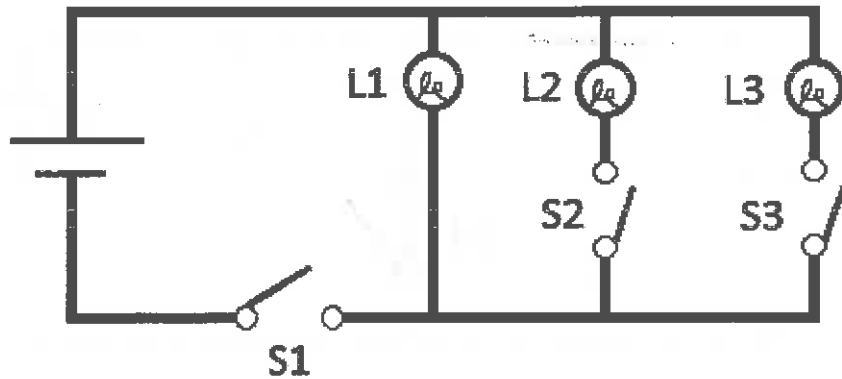
170. What would happen to the current intensity of a circuit if more resistors were added?

It would decrease

171. What would happen to the potential difference of a circuit if resistors were removed?

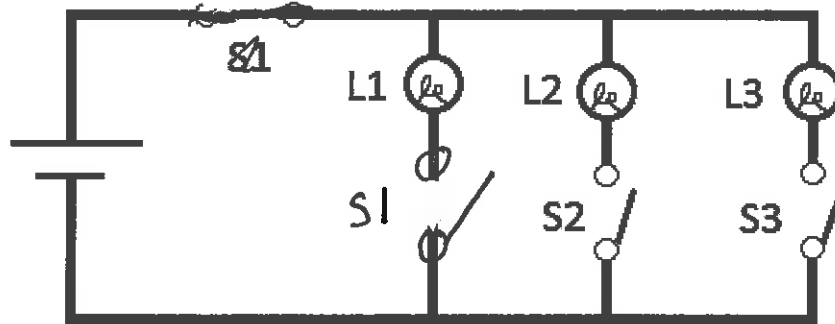
Nothing potential difference  
is controlled by the power source.

172. For the parallel circuit below, indicate which lights will be turned on or off for each of the switch arrangements displayed in the table.



Switches			Lights		
S1	S2	S3	L1	L2	L3
Closed	Closed	Closed	on	on	on
Closed	Closed	Open	on	on	off
Closed	Open	Closed	on	off	on
Open	Closed	Closed	off	off	off
Open	Open	Closed	off	off	off
Open	Closed	Open	off	off	off
Closed	Open	Open	on	off	off
Open	Open	Open	off	off	off

173. For the parallel circuit below, indicate which switches will be closed or open for each of the lighting arrangements displayed in the table.



Switches			Lights		
S1	S2	S3	L1	L2	L3
Closed	Open	Closed	On	Off	On
open	Closed	Closed	Off	On	On
Closed	Closed	open	On	On	Off
open	open	Closed	Off	Off	On
Closed	Closed	Closed	On	On	On
open	open	open	Off	Off	Off
open	Closed	open	Off	On	Off
Closed	open	open	On	Off	Off



## **The Material World**

### ***Periodic Table Checklist***

1. Locate the groups and periods in the periodic table
2. Describe the common characteristics of a group (e.g. number of valence electrons, chemical reactivity)
3. Associate the number of electron shells in an element with the number of its period
4. Describe the Rutherford-Bohr atomic model
5. Represent atoms using the Rutherford-Bohr model
6. Determine the number of valence electrons in an element
7. Represent atoms using Lewis notation

### ***Chemistry of Solutions Checklist***

8. Determine the concentration of an aqueous solution (g/L, percentage or ppm)
9. Define the concept of electrolyte
10. Describe the pH scale (acidity, alkalinity, neutrality, increasing and decreasing values)
11. Determine the pH of a few common substances (e.g. distilled water, rainwater, saliva, lemon juice, cleaners)
12. Describe electrolytic dissociation
13. Define the concept of ion
14. Describe the mechanism that allows aqueous solutions to conduct electricity (electrolytic dissolution of a solute, formation of mobile ions)

### ***General Chemistry Checklist***

15. Describe the perceivable manifestations of rapid combustion (e.g. heat, light)
16. Explain a combustion reaction using the fire triangle
17. Recognise and explains photosynthesis and respiration as chemical equations
18. Give examples of acid-base neutralization reactions (e.g. adding lime to neutralize the acidity of a lake)
19. Name the products formed during acid-base neutralization (salt and water)
20. Recognize an acid-base neutralization from its equation
21. Explain the law of conservation of mass during a chemical reaction
22. Represent the conservation of mass using the particle model
23. Balance chemical equations
24. Explain qualitatively the law of conservation of energy
25. Apply the law of conservation of energy in different contexts
26. Distinction between heat and temperature
27. Describe heat as a manifestation of energy
28. Describe the relationship between heat and temperature

Periodic Table

174. The following shows the Rutherford-Bohr model of an atom.

a) What is the name of the group this element belongs to?

Halogen

b) To what period does this element belong?

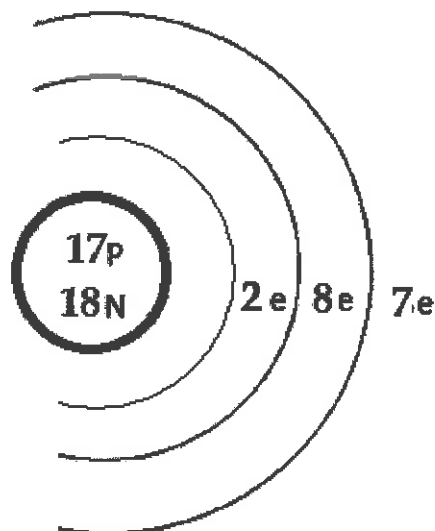
3rd

c) What is this element's atomic number?

17

d) What are the name and symbol of this element?

Chlorine "Cl"



175. The following shows the Rutherford-Bohr model of an atom.

a) What is the name of the group this element belongs to?

Boron Group

b) To what period does this element belong?

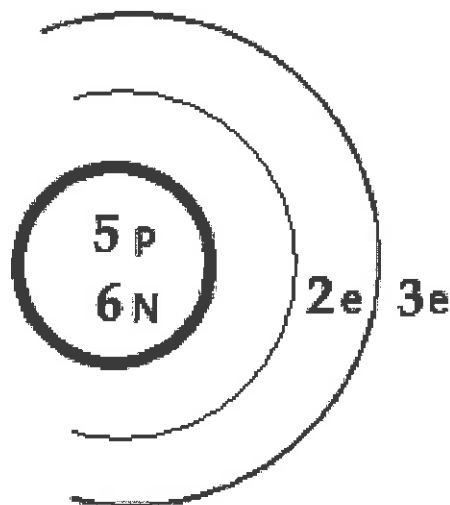
2nd

c) What is this element's atomic mass?

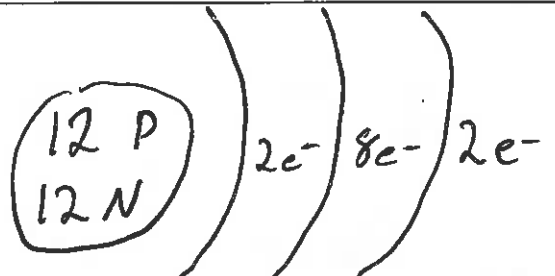
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d) What are the name and symbol of this element?

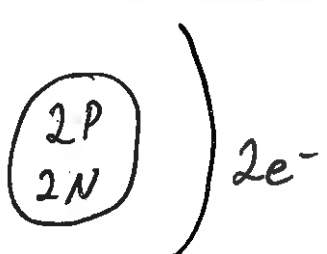
Boron B



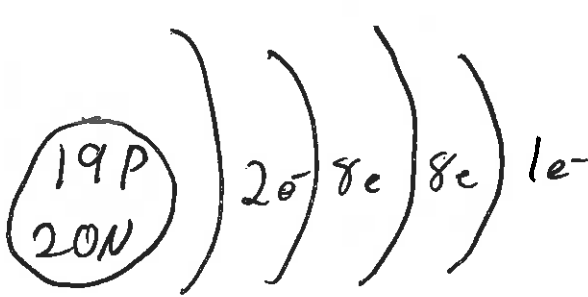
176. Write the symbol for the alkaline earth metal in period 3, and represent this element using the Rutherford-Bohr model.

Symbol	
<p>Mg</p> <p>Magnesium</p>	

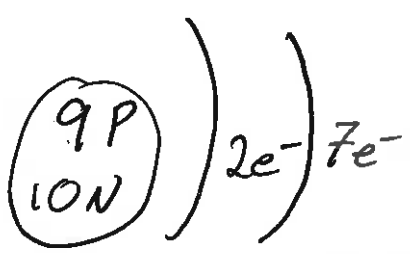
177. Write the symbol for the noble gas in period 1. Represent this element using the Rutherford-Bohr atomic model.

Symbol	
<p>He</p> <p>Helium</p>	

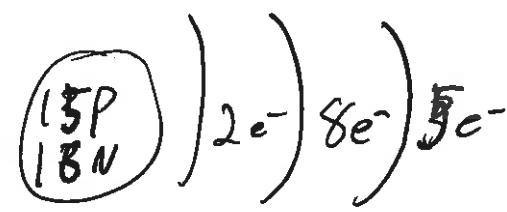
178. Write the symbol for the alkali metal in period 4. Represent this element using the Rutherford-Bohr atomic model.

Symbol	
<p>K</p> <p>Potassium</p>	

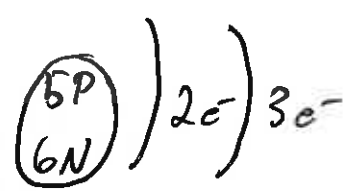
179. Write the symbol for the halogen in period 2. Represent this element using the Rutherford-Bohr atomic model.

Symbol	
<del>Ne</del> F Fluorine <del>Neon</del>	

180. Write the symbol for the group 5 element in row 3. Represent this element using the Rutherford-Bohr atomic model.

Symbol	
<del>Al</del> P Phosphorus <del>Aluminum</del>	

181. Write the symbol for the element in the third family and 2<sup>nd</sup> period. Represent this element using the Rutherford-Bohr atomic model.

Symbol	
B Boron	

182. Lithium is a metallic element with atomic number 3. Lithium is malleable, ductile, and lustrous and conducts electricity quite well. In contrast, nitrogen is a non-metal with atomic number 7. Nitrogen is a relatively inert gas that makes up the majority of our atmosphere. We use liquid nitrogen to flash-freeze foods for storage. Nitrogen has poor electro conductivity.

*Silicon* is an interesting element in that it sometimes conducts electricity and sometimes doesn't. It can be ductile and malleable but only in certain circumstances. It shares the qualities of metals and non-metals.

What do we call elements like *Silicon* which have the traits of metals and non-metals?

Metalloids

183. For each of the following descriptions, determine the group to which the element described belongs.

a) A non-metal with seven valence electrons that is used to disinfect and purify water.

VII

Halogen

Cl

b) A metal with one valence electron that is used as an ion in batteries.

I

Alkali Metals

Li

c) A metal with two valence electrons that can be found in our bones.

II

Alkaline earth metal

Ca

d) A non-metal which is essential to human life, has 6 valence electrons, composes 20% of the atmosphere and is used by cellular respiration/produced by photosynthesis.

Oxygen group VI

O

e) A non-metal which has eight valence electrons that is used in special light fixtures.

VIII

Nobel Gases

Ne

184. What is an ion?

An atom with a charge, that has lost or gained electrons

185. What can be removed or given to an atom to transform it into an ion?

Electrons

186. Refer to your periodic table.

Determine the number of valence electrons each of the elements has.

Draw the Lewis diagram.

Name the chemical group (family) to which the element belongs (example: alkali metals, alkaline-earth metals, halogens or inert/noble gases)

Element	Number of valence electrons	Lewis Diagram	Name of chemical group
Cl	7	$\cdot\ddot{\text{Cl}}\cdot$	Halogens
K	1	$\text{K}\cdot$	Alkali metals
Ar	8	$:\ddot{\text{Ar}}:$	Nobel Gases
N	5	$\cdot\ddot{\text{N}}\cdot$	Nitrogen group
Al	3	$\cdot\ddot{\text{Al}}\cdot$	Boron group
O	6	$\cdot\ddot{\text{O}}\cdot$	Oxygen group
C	4	$\cdot\ddot{\text{C}}\cdot$	Carbon group
Ca	2	$\text{Ca}\cdot$	Alkaline Earth Metals

187. Using the information provided below identify the elements described with their name and symbol.

- a) This element is a halogen with nine protons. It's the most reactive element and is used to whiten teeth and create powerful acids.

Fluorine F

- b) This element from period three has 13 protons. It's a lightweight metal used in foil and airplane construction

Aluminium Al

- c) An alkali metal that can be found in bananas and is in the fourth row of the periodic table.

Potassium K

- d) This element makes up every living creature on earth. It also forms pencil lead and diamonds. It has 6 protons and is found in the 2<sup>nd</sup> period of the periodic table.

Carbon C

- e) This element shares its name with the stone that emeralds are made of. It's an alkaline earth metal from the second row of the periodic table.

Beryllium Be

- f) This element is explosive in its pure solid form, but only if it gets wet. It has a single valence electron and can be found in the third period of the periodic table.

Sodium Na

- g) A very small and light atom that is the major component of many stars. It's also found in fossil fuels and water. It has only a single proton and one valence electron.

Hydrogen H

- h) This atom has its valence electron shell filled. It has 18 protons.

Argon Ar

### Chemistry of Solutions

188. When a neutrally charged atom gains electrons what does it become?

Negatively charged Anion

189. When sugar crystals ( $C_6H_{12}O_6$ ) are submerged in water the water molecules separate the sugar molecules dissolving them in the solution. When salt crystals ( $NaCl$ ) are submerged in water the water molecules separate the charged ions from one another ( $Na^+$  and  $Cl^-$ ).

What is the name of the process that occurs when the salt is submerged in water?

Dissociation

190. Does pure water conduct electricity?

No

191. What allows a solution to conduct electricity?

The presence of mobile charges  
such as ions in the solution

192. What is an electrolyte?

A solution containing ions, charged particles.



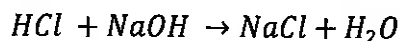
193. What is the difference between <sup>pure</sup>regular water and salt water that allows one to conduct electricity and not the other?

The salt water has charged ions while pure water doesn't. These charged ions are required to conduct electricity.

194. Indicate which of the following conduct electricity.

Solution	Conducts Electricity (YES/NO)
A metal plating bath filled with water and metal ions	Yes
Pure distilled and de-ionized water	no
Syrup made up of sugar and water	no
Salty ocean water	yes
Stomach Acid	yes

195. Observe the chemical reaction below and answer the following questions:



- a) What type of chemical reaction is this?

Acid-Base Neutralization

- b) What type of chemicals are the reactants?

$\text{HCl} = \text{Acid}$        $\text{NaOH} = \text{Base}$

- c) What kind of chemicals are the products?

$\text{NaCl} = \text{salt}$        $\text{H}_2\text{O} = \text{water}$

196. Hydrochloric acid is secreted by cells in our stomachs to help us digest our food. We have a layer of mucous in our stomachs to protect ourselves from this acid.

If we measured the pH of our stomach fluid, would we expect it to be greater or less than 7? Explain.

Less than 7, Acidic solutions have pH lower than 7. Since HCl is an acid it will lower the pH.

197. Indicate which colour the litmus paper would be if you tested each of the following solutions.

Solution	Litmus Test Colour
A broken bathtub at a crime scene filled with an HF solution	BLUE → Red
Vomit under a roller coaster containing HCl	RED → Red
A cleaning product made of equal parts of both $\text{NH}_3$ and $\text{CH}_3\text{COOH}$	BLUE → Blue
Oven-scrubber solution containing NaOH and $\text{NH}_3$	RED → Blue
The spit of a xenomorph containing HF and HCl	BLUE → Red
Pure de-ionized water	BLUE → Blue
Ocean Water	RED → Red

198. The pH of rain water is lower than the pH of lake water.

a) Which of the two is more acidic?

Rain Water

b) Which of the two is more basic?

lake water

199. To perform a medical test, a patient's blood (pH7) must be made 1000 times more basic.

What must the pH of the blood be during the test?

7 8 9 10 11 12 13 14      pH 10  
~~7~~ ~~8~~ ~~9~~ ~~10~~ ~~11~~ ~~12~~ ~~13~~ ~~14~~

200. A McGill student is testing the groundwater on the island of Montreal for acid rain. If the pH of the St. Lawrence river is 6 and the student find that the ground water of Montreal is 10 times more acidic, what is the pH of the ground water?

pH 5

201. What is described by the concentration of a solution?

The amount of solute dissolved ~~in~~  
 relative to the amount of solvent

202. Environmental scientists typically use the unit "ppm" (parts per million) to describe concentrations. Convert the following concentrations into ppm.

Original	Parts per million (ppm)
5% solution of sugar	50 000 ppm
6 g/L solution of thymine	6 000 ppm
100 g/L solution of albumin	1 000 000 ppm
0.05% solution of sodium hydroxide	500 ppm
.001 g/L solution of mercury	1 ppm
85% solution of methanol	850 000 ppm
0.0007g/l solution of carbonic acid	0.7 ppm

203. For the following pairs of salt solutions, indicate which is **MORE** concentrated.

Pair	More concentrated
3% and 3 ppm	3%
20% and 20g/L	20%
100 ppm and 0.1 g/L	Same
1g/L and 999 ppm	1g/L
10 000 ppm and 75 g/L	75 g/L
60% and 350 g/L	60%
120 000 ppm and 15%	15%

204. A 3L solution of salt water with a concentration of 12% is divided into three 1L jugs.  
What is the concentration of the salt water solution in each jug (in %)?

12%      The concentration doesn't change if the solution is split up.

205. What happens to the concentration of a solution if the volume is doubled?

The concentration is halved

206. A pitcher containing 2000 ml of iced tea contains 30 g of sugar. What is the sugar concentration of this solution in grams per liter?

$1\text{ L} = 1000\text{ g}_{\text{H}_2\text{O}} \text{ or } 1000\text{ mL}$   
 $\frac{30\text{ g}}{2\text{ L}} = \frac{15\text{ g}}{1\text{ L}}$

15 g/L

207. A variety of orange juice contains 25 g of carbohydrates per 250-mL serving. What is the concentration of carbohydrates in % m/V?

$$\frac{25g}{250mL} = 0.10 \times 100\% = 10\%$$

208. Which of the following is the most concentrated solution?

Solution	Concentration	
1	4% m/V	$\times 10 = 40g/L$
2	2g/100 ml	$\times 10 = 20g/L$
3	5g/L	$\times 10 = 50g/L$
4	10000mg/1500 ml	$\frac{10g}{1.5L} = 6.66g/L$

Solution 1  
is most concentrated

209. Synthetic fertilizers are used in the garden. We dissolve 0.1 g of fertilizer in 100 ml of water to make a solution. Calculate, in ppm, the concentration of this solution.

$$\frac{0.1g}{100mL} = \frac{x}{1000000mL} \quad 1000 \text{ ppm}$$

210. City regulations state that swimming pools must be closed when the concentration of free available residual chlorine in water is less than 0.3 ppm or greater than 5 ppm. The table below lists the concentrations of free available residual chlorine in water samples taken from four swimming pools.

Which of the pools has water that complies with these regulations?

Swimming Pool	Concentration of free available residual chlorine	
1	0.00002% (m/V)	$\times 10000 = 0.2 \text{ ppm}$
2	0.0004% (m/V)	$\times 10000 = 4 \text{ ppm}$
3	0.0004 g/L	$\times 1000 = 0.4 \text{ ppm}$
4	0.0058 g/L	$\times 1000 = 5.8 \text{ ppm}$

Only pool  
2 complies.  
The others  
must be closed

211. Which of the following solution(s) contain electrolytes? Explain your choice.

Solution	Electrical conductivity test	
1	Dim light	Solutions 1, 2, 4 contain electrolytes. They all passed the conductivity test and completed the light circuit
2	Strong light	
3	No light	
4	Strong light	

212. Identify the substances listed as acidic, basic or neutral.

Substance	pH	Acidic, Basic or Neutral
Egg white	7.6	Basic
Lime water	12.0	Basic
Maple syrup	6.7	Acidic
Vinegar	2.2	Acidic
Dissolved baking soda	8.3	Basic
Distilled water	7.0	Neutral
Peasoup	5.8	acidic

a) Which substance is the strongest base?

Lime water

b) Which substance is the strongest acid?

Vinegar

213. Classify the following substances by type of electrolyte (acid, base or salt).

Substance	Type of Electrolyte
$\text{H}_2\text{SO}_4$	Acid
$\text{Mg}(\text{OH})_2$	Base
$\text{HNO}_3$	Acid
KF	Salt
$\text{MgCl}_2$	Salt

General Chemistry

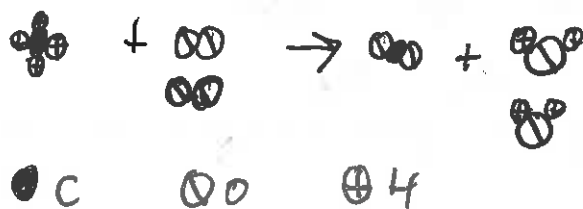
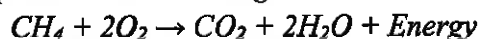
214. What is the meaning of the law of conservation of mass?

Matter cannot be created or destroyed  
the amount of matter in a closed system  
cannot change, neither can the mass.

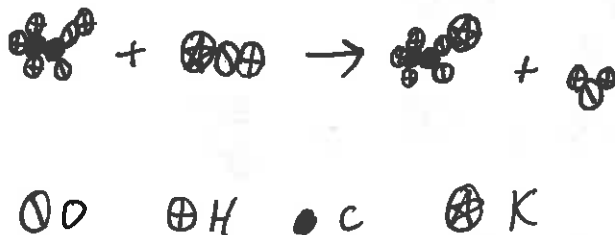
215. In what way does the law of conservation of mass affect our understanding of chemical reactions?

Both sides of a chemical reaction must be  
balanced in terms of mass and atoms.

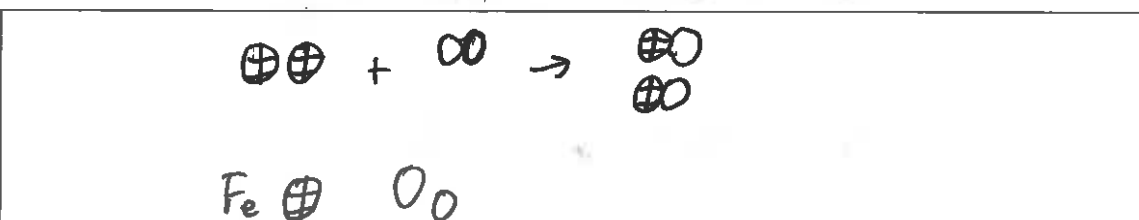
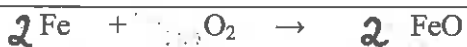
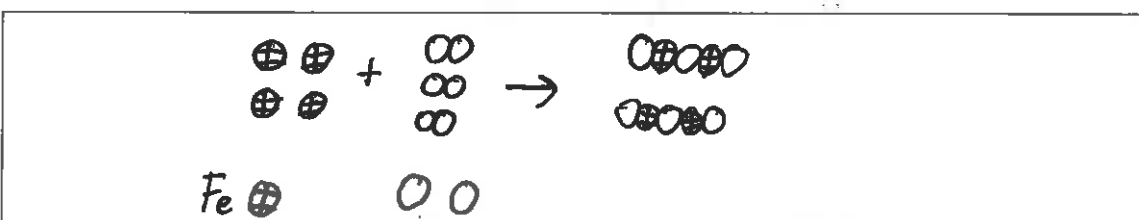
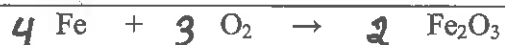
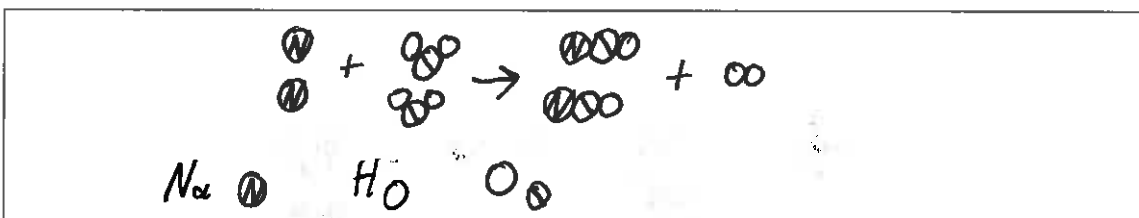
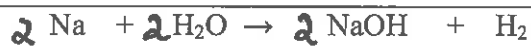
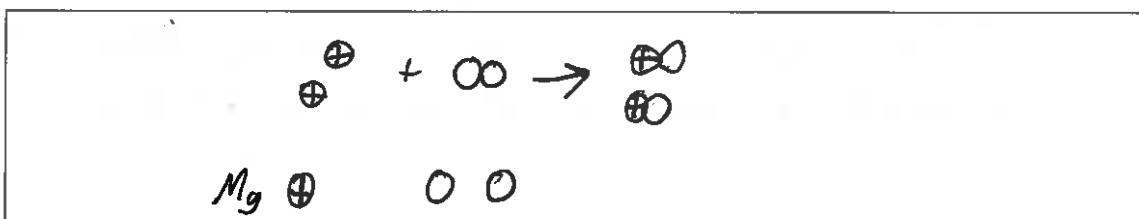
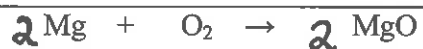
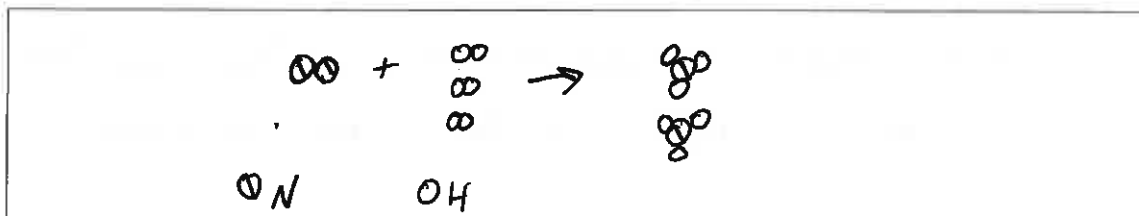
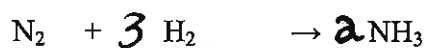
216. Using a ball model, represent the following balanced chemical reaction.



217. Using a ball model, represent the following balanced chemical reaction.



218. Balance the following equations and then draw diagrams of the molecules in the chemical reactions.





219. In a small lake affected by acid rain on Grand Island, 73 Kg of hydrochloric acid (HCl) reacted with calcium carbonate ( $\text{CaCO}_3$ ) to produce 111 kg of calcium chloride ( $\text{CaCl}_2$ ), 18 kg of water ( $\text{H}_2\text{O}$ ) and 44 kg of carbon dioxide ( $\text{CO}_2$ ). The balanced equation for a particular chemical reaction is:



What mass of calcium carbonate was needed to neutralize the small lake?

$$73\text{kg} + x \rightarrow 111\text{kg} + 18\text{kg} + 44\text{kg}$$

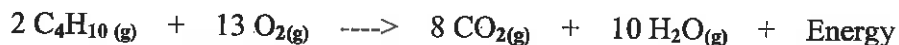
$$x = 100\text{kg of CaCO}_3 \quad \begin{matrix} \backslash / \\ 173\text{kg} \end{matrix}$$

220. In the lab, you react 8.5 g of  $\text{NaNO}_3$  with 9.8 g of  $\text{H}_2\text{SO}_4$ . You obtain 12.0 g of  $\text{NaHSO}_4$  and a certain quantity of  $\text{HNO}_3$ . What is this quantity of  $\text{HNO}_3$ ?

$$8.5\text{g} + 9.8\text{g} \rightarrow 12.0\text{g} + x\text{g}$$

$$\begin{matrix} \backslash / \\ 18.3\text{g} \end{matrix} - 12.0\text{g} = \boxed{6.3\text{g HNO}_3}$$

221. The reaction caused by the burning of butane in air is represented by the following equation:



During a laboratory experiment, you reacted 29 g of butane ( $\text{C}_4\text{H}_{10}$ ) in the presence of oxygen ( $\text{O}_2$ ). You observed that 88 g of carbon dioxide ( $\text{CO}_2$ ) and 45 g of water vapour ( $\text{H}_2\text{O}$ ) form.

What mass of oxygen gas ( $\text{O}_2$ ) did you use in this experiment?

$$29\text{g} + x \rightarrow 88\text{g} + 45\text{g}$$

$$\begin{matrix} \downarrow \\ \boxed{104\text{g O}_2} \end{matrix} \quad \begin{matrix} \backslash / \\ 133\text{g} \end{matrix}$$

222. What is the difference between heat and temperature?

Heat is a form of energy; infrared radiation  
Temperature is a measure of the average kinetic energy of the particles in a substance.

223. Chemical reactions often give off energy when they occur. What are two forms of energy released in a combustion reaction?

Heat or Thermal

Light, Luminous

224. What are three necessary conditions for combustion to occur?

Oxidant

Fuel Source

Heat

225. Which part of the fire triangle is involved in each of the following situations?  
Explain your answers.

- a) The carbon dioxide ( $\text{CO}_2$ ) gas that comes out of an extinguisher is a powerful spray that puts out small paper fires by scattering the pieces of material involved.

Fuel

- b)  $\text{CO}_2$  from an extinguisher has a cooling effect as it comes out of the extinguisher at a temperature of  $-78^\circ\text{C}$ .

Heat

- c) During a forest fire, firefighters begin clear-cutting a threatened area. They cut a 50-m-wide stretch of forest a few kilometres ahead of the fire.

Fuel

- d) A fire blanket can smother a fire.

Oxidant

226. Examine the following chemical reaction and answer the questions:



- a) What is the name of this chemical reaction?

Cellular Respiration

- b) What are the two reactants in this chemical reaction?

Glucose  
 $\text{C}_6\text{H}_{12}\text{O}_6$

Oxygen  
 $\text{O}_2$

- c) What are the three products in this chemical reaction?

Water  
 $\text{H}_2\text{O}$

Carbon dioxide  
 $\text{CO}_2$

Energy  
ATP

- d) The following reaction can be seen as an opposite to the one above:



What is this reaction called?

Photosynthesis

- e) Where does the reaction shown in "d" occur?

In the chloroplasts of plant and algal cells

## **Earth and Space**

### ***Hydrosphere Checklist***

1. Define a catchment area as a territory surrounding a waterway
2. Describe some of the impacts of human activity on the waterways in a catchment area
3. Define salinity as a measure of the quantity of salt in a solution
4. Describe the influence of salinity on the density of a solution
5. Describe factors that affect the circulation of surface currents and deep currents
6. Describe the role of thermohaline circulation on global climate regulation
7. Distinguish between glaciers and ice floes
8. Describe some of the impacts of the melting of glaciers and ice floes
9. Describe the tides in terms of the gravitational effect of the Earth-Moon system

### ***Atmosphere Checklist***

10. Describe the greenhouse effect
11. Explain some of the consequences of a higher concentration of greenhouse gases (e.g. global warming that could result in higher sea levels, disturbances in ecosystems or the melting of glaciers)
12. Describe the properties of an air mass (temperature, humidity, pressure)
13. Explain the formation of clouds when two different air masses meet
14. Describe the main factors responsible for atmospheric circulation (e.g. pressure variations, uneven heating of the Earth's surface)
15. Explain the formation of cyclones (low-pressure areas) and anticyclones (high-pressure areas)
16. Describe the main factors that affect the quantity of solar energy that reaches the Earth's surface (e.g. reflection and absorption of solar energy by the atmosphere or surfaces)

### ***Lithosphere Checklist***

17. Distinguish between minerals and ore
18. Describe some of the environmental impacts of mining or of the transformation of minerals
19. Describe the structure of a soil
20. Explain the chemical and biological reactivity of a soil based on its composition
21. Define the permafrost as a layer of permanently frozen soil
22. Explain some of the consequences of a rise in temperature in the permafrost

### ***Biosphere Checklist***

23. Describe transformations related to the circulation of carbon (e.g. photosynthesis, plant decomposition, dissolution in water, combustion of fossil fuels)
24. Describe transformations related to the circulation of nitrogen (e.g. nitrogen fixation, nitrification, denitrification)
25. Describe the geographical and climatic factors that affect the distribution of biomes (e.g. latitude, humidity, temperature, salinity)
26. Describe different terrestrial biomes (e.g. fauna, flora, climate, type of soil)
27. Describe different marine biomes (e.g. fauna, flora, temperature, salinity)

### ***Energy Resources Checklist***

28. Describe technologies used to produce electricity using the energy resources in the lithosphere, hydrosphere and atmosphere
29. Describe the main impact of the use of energy resources in the lithosphere, hydrosphere and atmosphere

### Hydrosphere

227. In the diagram below, the dotted circle represents the moon's orbit around the Earth.

- Draw the crescent symbol on the dotted circle to indicate the two (2) points in the lunar orbit where the moon causes the high tides in Ungava Bay. The position of this bay is denoted by the human symbol.
- Write the letter L on the Earth to indicate the two (2) points where the tides are low at the same time as the tide is high in Ungava Bay.

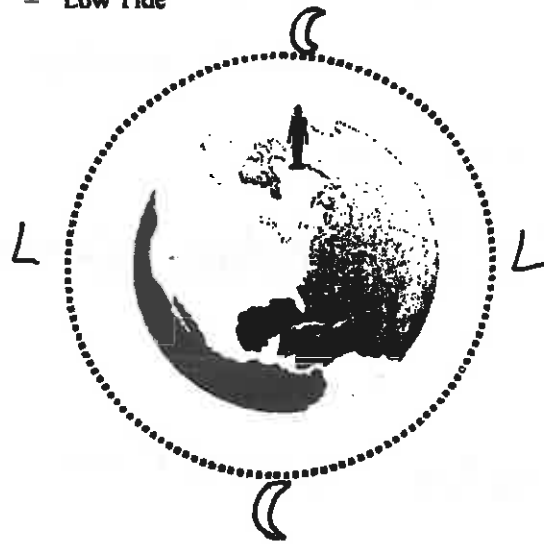
In the diagram below, the dotted line represents the moon's orbit around the Earth.

#### Symbols

♀ = Ungava Bay

☾ = Moon

L = Low Tide



228. What is a catchment area (watershed)?

The region in which water drains to a specific place. ex. St. Lawrence watershed

229. Name three types of human activity that can cause an impact on the waterways in a catchment area (watershed).

A dam	urban development	Agriculture
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230. What is salinity?

A measure of the amount of salt dissolved in a solution

231. Which is denser: distilled water, lake water or ocean water? Explain.

Ocean water, it has more salt greater salinity

232. What causes surface ocean currents?

Drainage ~~Thermohaline circulation~~

233. What causes subsurface ocean currents?

Thermohaline Circulation.

234. Which is denser, cold water or warm water?

Cold water

235. How is oceanic circulation important in regulating global climate?

Ocean currents move the water in certain directions to or from the Poles and equator. This

236. What is the major difference between an ice floe and a glacier?

A Glacier is a compressed mass of snow and ice that forms on land

An ice floe is frozen ocean water floating near the poles

237. What two effects do the melting of glaciers and ice floes have on Earth?

Slow thermohaline  
Circulation

sea level Rise  
(Glaciers only)

#### Atmosphere

238. What is the greenhouse effect?

A natural process that allows the earth to retain heat by capturing it in the atmosphere

239. Name four greenhouse gases that are found in the Earth's atmosphere.

water Vapour $H_2O$	$NO_2$ Nitrous Oxide
Carbon dioxide $CO_2$	Methane $CH_4$

240. Name two causes of the intensification of the greenhouse effect.

Burning fossil fuels to produce $CO_2$	Destruction of forests
---	------------------------

241. 66 million years ago the region around Mumbai was devastated by incredible volcanic eruptions. It is theorized that these eruptions helped cause the extinction of the dinosaurs by changing the climate.

**What effect can volcanoes have on global climate change?**

They emit  $\text{CO}_2$  ~~and~~ a greenhouse gas that can contribute to global warming

242. Describe a consequence of a higher concentration of greenhouse gases in the atmosphere.

- abnormal climate change
- Melting permafrost, causing flooding & ecosystem change
- Melting pack ice and Glaciers slow thermo haline circulation

243. An air mass that originated from the Caribbean lies over Quebec, while a fast-moving air mass from the far north is heading down towards it.

**Explain what happens when the air mass from the far north meets the air mass from the Caribbean. In your explanation, discuss the various phenomena involved.**

Causes cyclones, powerful storms

- Flooding
- property damage
- infrastructure damage



244. The weather forecast for the next week states that a cold Northeast wind has moved off the coast of New Brunswick, originating from the North Pole. Over the next few days, an air mass will be moving in off the coast of Jamaica towards the Monteregion region of Quebec.

**Explain what will happen when the two air masses meet. Your explanation must include the various phenomena involved.**

If the mass is cold they will meet and produce dark clouds and heavy rain

If the mass is warm the clouds and rain will be light

245. What causes winds to blow?

Differences in air pressure

wind Blows from High → low pressure

246. Cyclist A leaves Montreal for Quebec while at the same time, Cyclist B of equal ability leaves Quebec for Montreal. If a high pressure system is hanging over Quebec, and a low pressure system is hanging over Montreal, which cyclist A or B will be first to arrive at his destination. Explain your answer.

wind Blows Quebec → Montreal

Cyclist B arrives first, They are riding with the wind

cyclist A is riding against it

247. What happens to the density of air as it is warmed up in the atmosphere? Explain.

decreases, particles move faster and further apart.

248. What happens to the density of air as it is cooled in the atmosphere? Explain.

increases, particles move slowly closer together

249. What do you call an area of atmospheric circulation surrounding an area of high pressure?

Anticyclone

250. What do you call an area of atmospheric circulation surrounding an area of low pressure?

Cyclone or depression

251. What type of weather do you expect in an area of high pressure. Explain.

clear skies

252. What type of weather do you expect in an area of low pressure? Explain.

Cloudy or precipitation

### Lithosphere

253. What is the difference between a mineral and an ore?

An ore is a rock containing a mineral with mining potential

Mineral: Solid, inorganic, clearly defined properties

254. Look at the illustration opposite.

Name each of the soil layers.

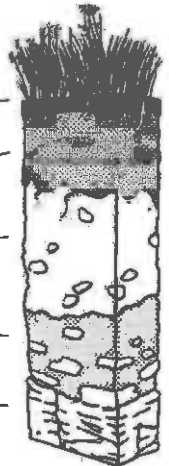
Organic matter

topsoil

subsoil

fragmented Parent Rock

Unaltered parent Rock



255. At the student horticulturists' market, they are selling 25-L bags of soil labelled "Garden soil." Which soil layer is removed to fill these bags? Explain your answer.

Topsoil

256. What is permafrost?

Soil at below 0°C temperatures where the water is permanently frozen.

257. What is a consequence of a rise in temperature in the permafrost?

it will melt, causing landslides, increased primary productivity, CO<sub>2</sub> release, unstable infrastructure

258. When permafrost melts, what happens to the primary productivity in the region?

it increases

#### Biosphere

259. What is the process by which plants and algae capture carbon dioxide and transform it into glucose called?

Photosynthesis

260. To survive, many living organisms burn glucose or other sugars and breath out carbon dioxide. What is the name of this process?

Cellular Respiration

261. Bacteria and fungi digest the waste or detritus left by other organisms. The bacteria and fungi fill a special role in the carbon cycle. What is that role called?

Decomposers

262. Carbon dioxide dissolved in water can react with water and calcium to form a chemical called calcium carbonate. **What is this calcium carbonate used for in aquatic ecosystems?**

shells and skeletons of  
marine animals

263. Mufasa the lion tells his son Simba that when they die, their bodies become the grass and the antelope eat the grass just as lions eat the antelope. Mufasa states that everything is connected in the great circle of life.

**This circle forms a cycle of matter within the environment. What would human scientists call this cycle?**

Chemical Recycling

264. The carbon that exists in dead organisms can sometimes be buried very quickly by rivers and floods. These remains are then transformed into new substances that we use to produce electricity, power our cars and heat our homes.

**What are these new substances called?**

fossil fuels

265. Animals, and some plants, eat other organisms to acquire carbon and other nutrients they need to grow. Almost all animals do this by biting or breaking a piece off another organism and pulling it into their own bodies.

**What is this process, which precedes digestion, called?**

Ingestion

266. Nitrogen is the most common gas found in our atmosphere and is also an important nutrient for all living organisms. **What are two things that all living organisms need that require nitrogen to be made?**

Proteins	DNA, genetic material
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267. Despite its abundance in the atmosphere, most organisms cannot use nitrogen gas for biochemical reactions. Before other organisms can access the nitrogen it must be transformed into ammonia. **What is this process called?**

Nitrogen fixation
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268. Bacteria further oxidize the ammonia into nitrites through a different process. **What is the name of this process?**

Nitrification
---------------

269. **What is the name for the group of organisms that acquire nutrients such as carbon and nitrogen by eating or feeding on other organisms?**

Consumers
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270. There are many different types of bacteria in the world, some actually do the complete opposite of the bacteria discussed in question 258 and 259. These bacteria transform nitrates back into atmospheric nitrogen gas. **What is this process called?**

denitrification
-----------------

271. What are biomes?

Large regions of the world with  
distinctive climate and ecosystems

272. Which terrestrial biome has the most biodiversity? Explain.

Tropical Rain forests - lots of water available  
- large insolation (a lot of sunlight)

273. Which terrestrial biome has the least biodiversity? Explain.

Deserts, due to low water availability  
and poor soil nutrients

274. Which terrestrial biome is the most at risk from climate change? Explain.

Arctic tundra, changing into boreal forest  
due to rising temperatures

275. How is a freshwater biome different than a marine biome?

It has lower salinity

marine = salt water

276. Name three different types of freshwater biomes.

wetlands

swamps

marshes

Rivers

Lakes

277. Name three different types of marine biomes.

estuaries	Oceans Seas	Coral Reefs
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### Energy Resources

278. If I am to build a beautiful hotel on a remote gently volcanic island (it won't explode, I checked) in the Pacific Ocean; I need some way to power the various electrical appliances my hotel will need to function. It's too expensive to buy coal, oil or natural gas and ship it to my island and the island has no large rivers. My resort is also hit by powerful tropical storms in the late summer so I can't build wind turbines either. What are the electricity options still available to me? Explain why one of them works.

Tidal, Geothermal, Solar
Tidal: Underwater renewable and not vulnerable to storms
Solar: Very effective in tropics.
Geothermal: works well in weakly volcanic regions

279. An environmental group has asked a company to consider using electricity from renewable energy resources. These energy resources can be found in the lithosphere, hydrosphere and atmosphere. Give an example of an energy resource used to generate electricity for each of the lithosphere, hydrosphere and atmosphere.

Sphere	Energy Resource
Lithosphere	Geothermal, fossil fuels, Nuclear
Hydrosphere	Tidal, Hydroelectric
Atmosphere	Wind, Solar



280. Fill in the table below.

Source	Layer of the layer where the energy comes from (atmosphere, hydrosphere or lithosphere?)
Hydroelectric energy	Hydro sphere
Fossil energy	lithosphere
Wind energy	atmosphere
Tidal energy	Hydro sphere
Geothermal energy	lithosphere
Solar energy	atmosphere

