2011 Part A: Short-Answer Questions
Questions 1 to 9
Answer all questions in your *Answer Booklet*.

Question 1

The reaction below represents the neutralization of the base $Ca(OH)_2$ with the acid H_3PO_4.

$Ca(OH)_2$	+	H_3PO_4	$\longrightarrow$	________	+	________
				dihydrogen monoxide		calcium phosphate

Using the rules of nomenclature, name the reactants and write the molecular formula for the products, in your *Answer Booklet. You do not need to balance the equation.*

Question 2

Nitrogen fixation is the chemical process that changes atmospheric nitrogen to ammonia. It can be described by the chemical equation:

$$N_2 + 3H_2 \rightarrow 2NH_3 + \text{heat}$$

Is this chemical reaction endothermic or exothermic?

Question 3

What is the chemical equation for the oxidation of aluminum? *You do not need to balance the equation.*

Question 4

Draw a diagram of the simplified atomic model for the element argon (Ar).

Question 5

Refer to the illustration of the compass and electromagnet in Figure 1 below.

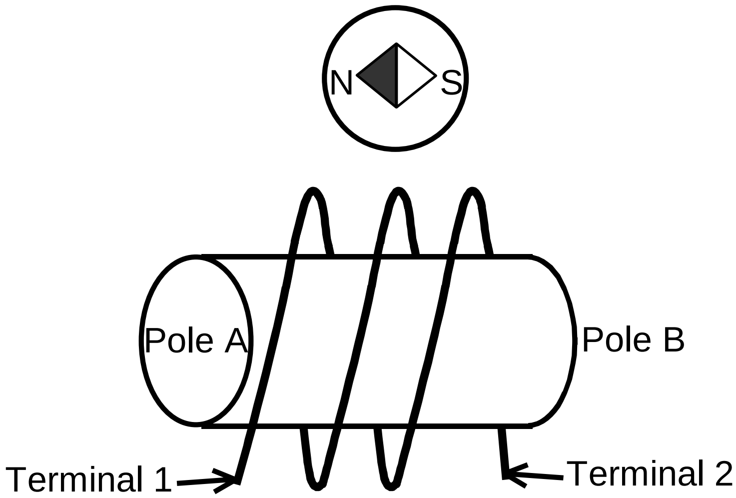


Figure 1: Compass and Electromagnet

a)	Fill in the blanks in your *Answer Booklet* using the words **positively**, **negatively**, **north** or **south**.

b)	In your *Answer Booklet*, list two ways in which the strength of an electromagnet can be increased.

Question 6

Chlorine, Cl, has two isotopes that are found in nature. The relative abundance of Chlorine 35 is 76%. The other isotope of chlorine has 20 neutrons.

Calculate the average atomic mass of chlorine.

Write your answer to two decimal places. *Ignore significant figures.*

Question 7

Two (2) litres of water begins to boil after absorbing 670 400 J of heat energy.

Calculate the initial temperature of the water.

Question 8

In 2009 Hydro-Québec measured mercury levels in fish from the Eastmain and Opinaca reservoirs and found that they were significantly higher than in 2004. Using the data published by Hydro-Québec, the Cree Health Board made the following recommendations for three groups of fish in this area:

- for one species of fish they recommend 2 or more servings weekly.
- for the other two species of fish they recommend only 1 serving or less per month.

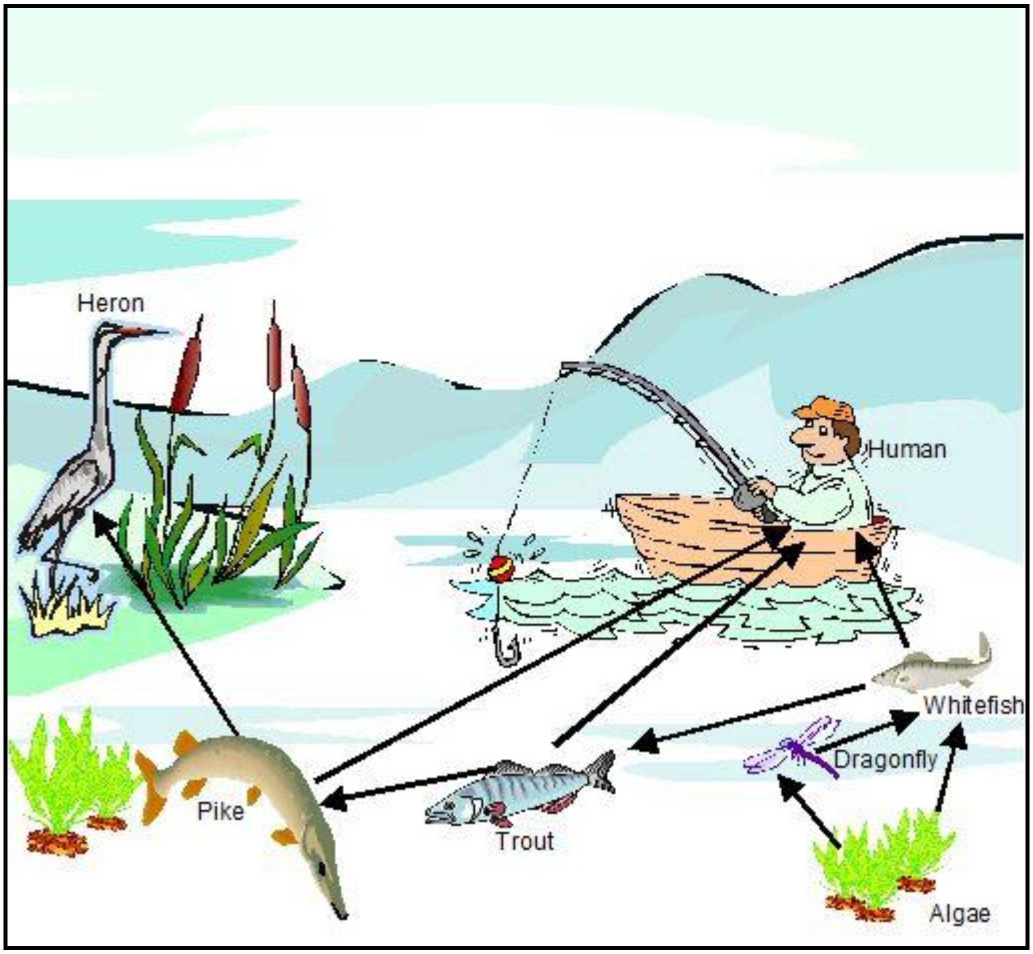


Figure 2: Food Web of the Eastmain and Opinaca Reservoirs

a)	Use the food web in Figure 2 to determine which species of fish can be eaten more often than the other.

b)	Justify your answer using scientific concepts.

Question 9

Mr. Logan is pulling his son James on a sled at a constant velocity. Mr. Logan is exerting a force of 50.0 N at an angle of 40.0° to the horizontal as shown in Figure 3.

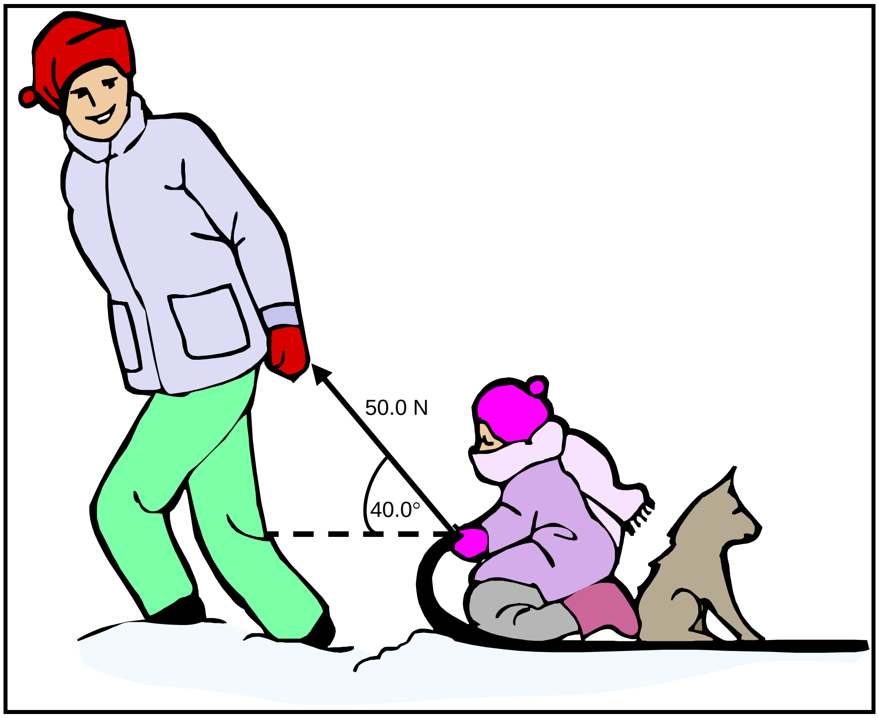


Figure 3 : Mr. Logan and his son James

Calculate the amount of work that Mr. Logan is doing when he pulls James a total of 2.0×10^2 meters.

Part B: Long-Answer Questions

Questions 10 to 14

Answer all questions in your *Answer Booklet*, showing all your work.

Question 10

Refer to the illustration of Circuit A and Circuit B in Figure 4 below.

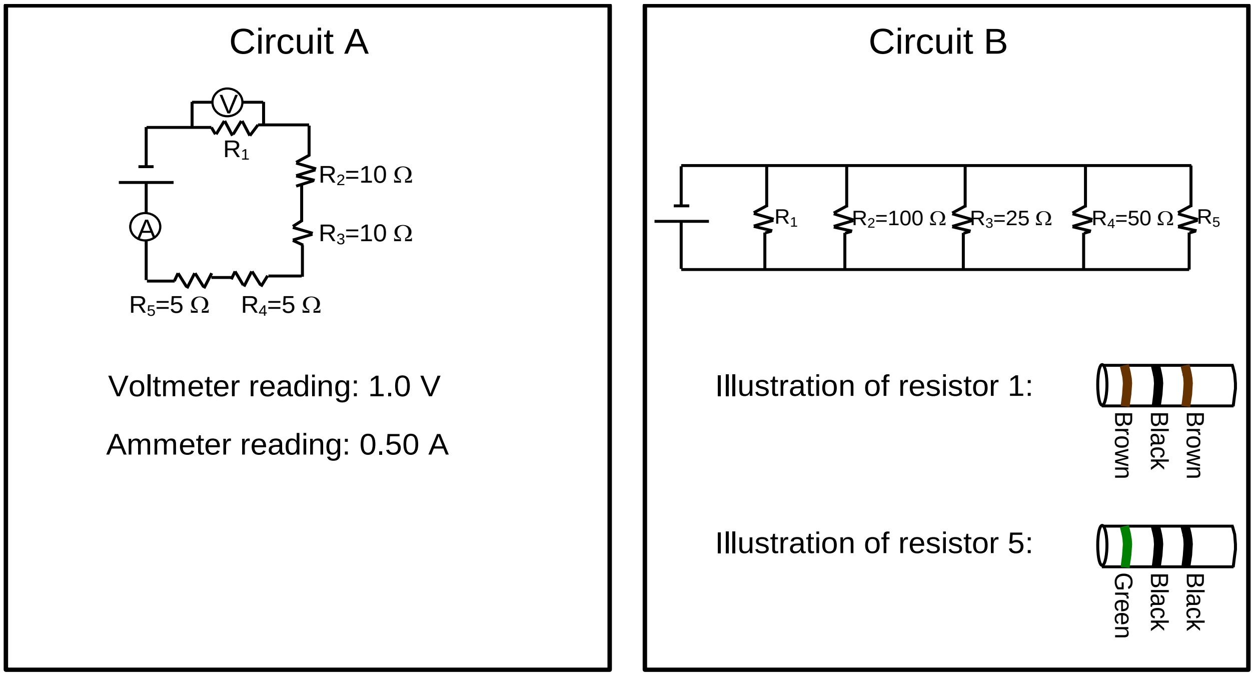


Figure 4 : Illustrations of Circuit A and Circuit B

Which of the two circuits (Circuit A or Circuit B) has the greatest resistance?

Refer to the Resistor Colour Chart, Appendix 4.

Question 11

In redesigning a camp, the manager wishes to rebuild the cafeteria building.

Figure 5 represents an illustration of the cafeteria building he wishes to build.

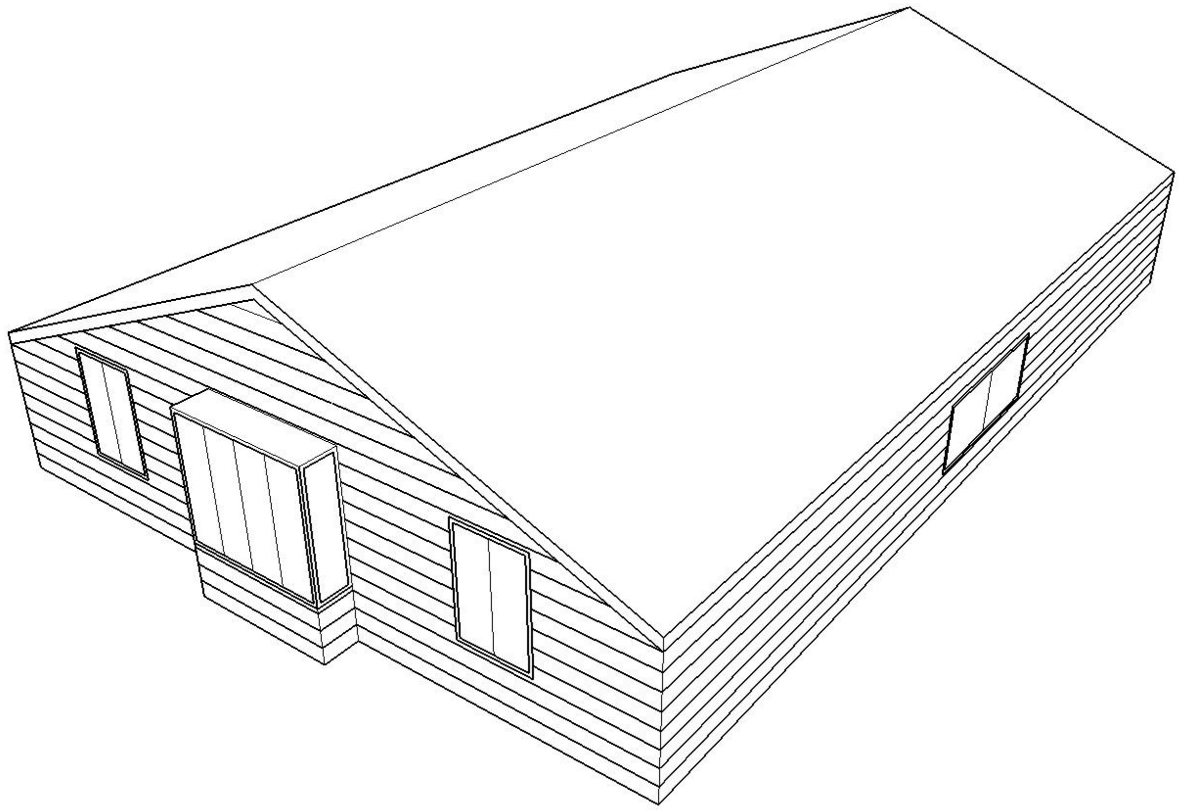


Figure 5 : Cafeteria Building

- He has asked you to make a simple blueprint showing **three views** of the building that he can send to the architect.
- The cafeteria should be 20 meters wide by 30 meters in length, have a maximum height of 8 meters in the center and a height of 4 meters at the edges.
- At one end of the cafeteria is a Bay window that is 4 m wide and 5 m tall. It extends out 1 m from the cafeteria building.

Use the grid paper in your *Answer Booklet* to draw the three views of the multiview orthogonal projection of the cafeteria building.

Question 12

A camp opens every year with a simple fireworks demonstration. Black powder is used as the active ingredient.

The balanced chemical equation for the reaction is:

$$2\ KNO_3 + S + 3\ C \rightarrow K_2S + N_2 + 3\ CO_2$$

If 20.0 g of carbon are used, what mass of K_2S will be produced in the reaction?

Question 13

A camp has a waterslide that is 5.0 meters high. Debra, a 55 kg camper, is sliding down the waterslide from rest. See Figure 6 below.

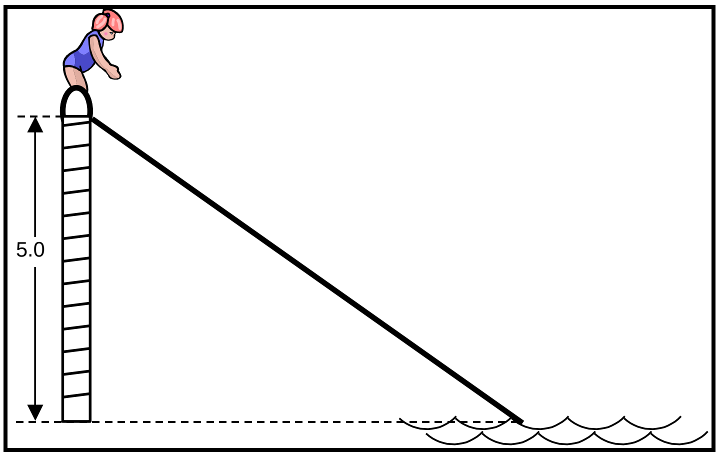


Figure 6: Waterslide

a)	How fast will Debra be travelling when she reaches the water? Neglect resistance forces (air and friction).

b)	Explain, using scientific terminology, why doubling the velocity of an object increases the kinetic energy by a factor of four.

Question 14

Campers are planning to grow pea plants in the camp garden. They can only get two varieties of seeds from the supply store. One type is heterozygous for round seeds and yellow seeds. The other type is homozygous for wrinkled seeds and green seeds. To increase the variety of peas in their garden the campers plan to cross these pea plants.

R = round seeds
r = wrinkled seeds

Y = yellow seeds
y = green seeds

Determine the expected ratio of **phenotypes** from this cross. The alleles should be written as shown above.

Part C: Forming an Opinion

Question 15

Answer the question in your *Answer Booklet*. Use the following information in the description of the context as well as in the background materials provided.

CONTEXT

An organization is preparing to build a lakeside campground in rural Québec for at-risk youth. The organization has selected two possible locations where they would like to build the camp as illustrated in Figure 7. Unfortunately, cyanobacteria (blue-green algae) blooms and eutrophication are becoming a problem in the lakes in this area of Quebec.

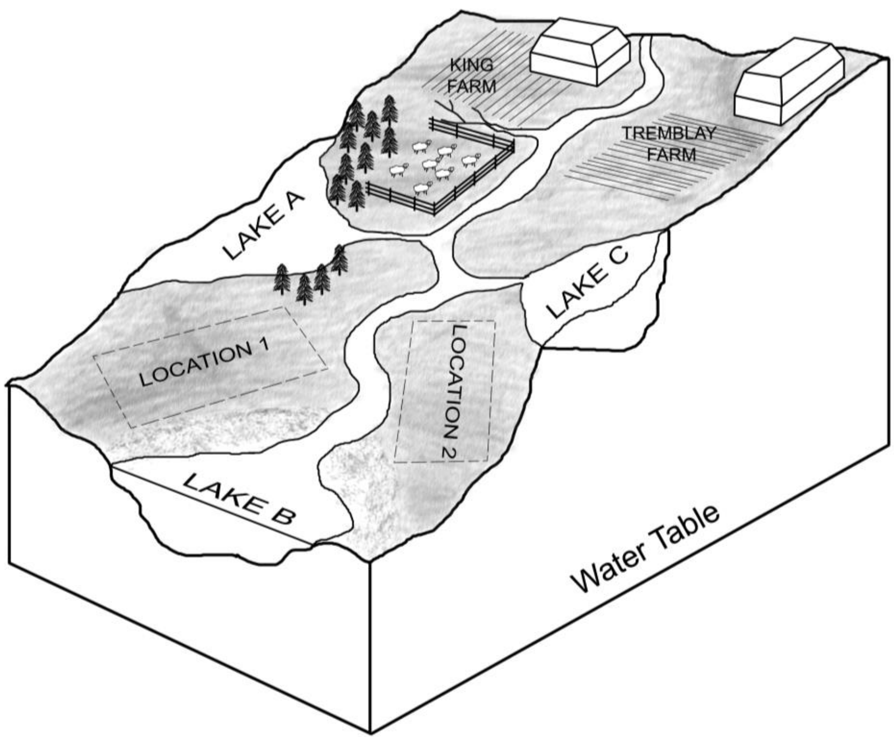


Figure 7: Possible Geographical Locations for the Campground

Choose **one** of the two proposed locations as the most appropriate area to build the camp. Justify your choice with two arguments and a conclusion. The two arguments must be based on the following:

1. The background material provided and the information in the description of the context.
2. Your knowledge of science and technology.
3. More than one aspect: social, health, environmental, economic, political, technical, ethical, etc.

BACKGROUND MATERIAL

What are cyanobacteria?

Cyanobacteria is the scientific name for blue-green algae or ‘pond scum.’ The first recognized species was blue-green in colour, which is how the algae got its name. Species identified since discovery can range in colour from olive-green to red.

Blooms in recreational bodies of water are usually associated with unpleasant odours and offensive appearance on shorelines as the scum accumulates and decays. Although cyanobacterial toxins are not likely to be absorbed through the skin, they can cause skin irritation. The toxins can enter the body via ingestion of water or can become airborne and inhaled. Beaches located on lakes with areas containing toxic algal blooms must be closed.

Health effects of Cyanobacteria

Cyanobacterial cells contain cyanobacterial toxins. Some are known to attack the liver (hepatotoxins) or the nervous system (neurotoxins), while others simply irritate the skin (dermatoxins). These toxins are usually released into water when the cells rupture or die.

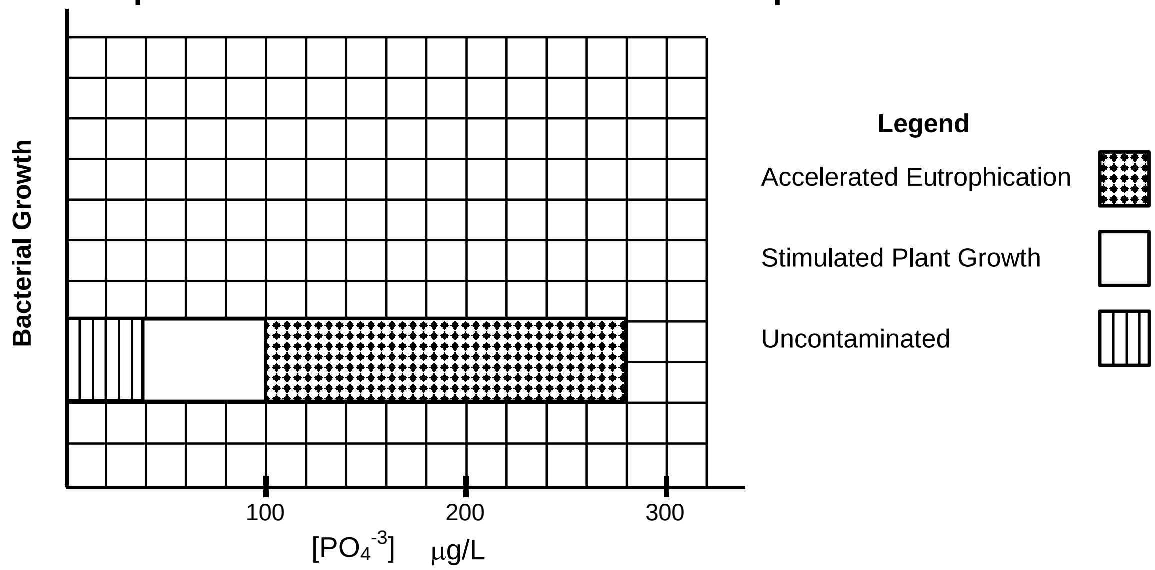
Some of these toxins are extremely stable in water because of their chemical structure. They resist decomposition in both warm and cold water and can tolerate radical changes in water chemistry, including pH.

Factors that affect the growth of Cyanobacteria

Blue-green algal blooms occur when certain environmental conditions are met. They bloom more frequently when the concentration of phosphates and nitrogens are high. Graph 1, on the following page, shows the potential for bacterial growth with respect to phosphate concentrations. The optimal temperature for algal growth is 25°C. Growth is slower when exposed to constant periods of high intensity light, but faster when exposed to intermittent high light. Low turbidity allows for more light in the water column and promotes algal growth. Cyanobacteria also prefer stable water with little to no flow, light winds, and minimal turbulence.

The potential for bacterial growth with respect to phosphate concentrations is demonstrated below by showing various levels of phosphates in μg/L (micrograms per litre).

Graph 1: Bacterial Growth in Relation to Phosphate Concentration



Current conditions

Phosphate Concentration

The three lakes were tested for phosphate concentration. Water samples were taken over a one week period at each of the three lakes. Unfortunately, the amount of water taken at each lake was not the same. Researchers used 50.0 mL samples for Lake A, 200.0 mL samples for Lake B, and 25 mL samples for Lake C.

Table 1 – Phosphate Concentrations in Micrograms per Litre

	Lake A μg per 50 mL sample	Lake B μg per 200 mL sample	Lake C μg per 25 mL sample
Monday	4.5	5.8	4.3
Tuesday	4.2	5.8	4.1
Wednesday	4.8	6.0	4.2
Thursday	4.9	5.6	4.2
Friday	4.6	5.6	4.3
Saturday	4.0	5.3	3.9
Sunday	3.8	5.1	4.4
AVERAGE	______ μg per 50.0 mL sample	______ μg per 200.0 mL sample	______ μg per 25 mL sample

Air and Temperature

Over the last three years air and water temperatures were taken on the dates shown. The results are presented below.

Date	Air Temp (°C)	Lake A water Temp (°C)	Lake B water Temp (°C)	Lake C water Temp (°C)
July 1	24.5	22.6	22.1	21.6
July 15	26.0	24.4	23.8	22.8
July 30	25.5	26.5	26.0	24.5
Aug 15	25.0	25.7	25.2	24.2
Aug 30	22.8	25.3	24.4	23.4
Average				

Table 2: Air and Water Temperature

Other Factors

Lake A has several large trees on its upper bank, providing shade at various times during the day. The nearby King Farms raises sheep and grows feed corn.

A large stream flows into Lake B. The stream is shallow and rocky creating rapids.

A major corn producer, Tremblay Farms, is just above Lake C. There are no trees surrounding Lake C. Lake C is much deeper than the other two lakes.

Appendix 1

FORMULAS

Formula	Symbols	Formula	Symbols
$C = \frac{m}{v}$	C: concentration m: mass V: volume	$W = \Delta E$	W: work ΔE: variation in energy
$V = RI$	V: potential difference R: resistance I: electric current intensity	$W = F\Delta d$	W: work F: force Δd: distance travelled
$R_{eq} = R_1 + R_2 + \ldots$	R_{eq}: equivalent resistance	$F_g = mg$	F_{g}: gravitational force m: mass g: gravitational field intensity
$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$	R_{eq}: equivalent resistance	$E_p = mgh$	E_{p}: gravitational potential energy m: mass g: gravitational field intensity h: height
$E = P\Delta t$	E: energy consumed P: power t: time	$E_k = \frac{1}{2}mv^2$	E_k: kinetic energy m: mass v: velocity
$P = VI$	P: power V: potential difference I: electric current intensity	$Q = mc\Delta T$	Q: quantity of heat m: mass c: specific heat capacity ΔT: change in temperature
$F_e = \frac{kq_1q_2}{r^2}$	F_{e}: electrical force k: Coulomb's constant q: charge of particle r: distance between two particles		

Appendix 2

QUANTITIES		
NAME	**SYMBOL**	**VALUE**
Coulomb's constant	k	$9 \times 10^9 \frac{Nm^2}{C^2}$
Gravitational field intensity	g	9.8 N/kg
Specific heat capacity for water	c	$4.19 \frac{J}{g°C}$

Appendix 3

Examples of Common Polyatomic Ions

NAME	CHEMICAL FORMULA
Acetate	CH_3COO^-
Ammonium	NH_4^+
Bicarbonate	HCO_3^-
Carbonate	CO_3^{2-}
Chlorate	ClO_3^-
Chromate	CrO_4^{2-}
Hydroxide	OH^-
Nitrate	NO_3^-
Phosphate	PO_4^{3-}
Sulphate	SO_4^{2-}

Appendix 4

Resistor Colour Chart

Colour	Black	Brown	Red	orange	Yellow	Green	Blue	Purple	Grey	White
Digit	0	1	2	3	4	5	6	7	8	9
Multiplier	10^0	10^1	10^2	10^3	10^4	10^5	10^6	10^7	10^8	10^9

Appendix 5

PERIODIC TABLE OF THE ELEMENTS

Key

1 (Atomic number)
H (Element Symbol)
1.01 (Atomic Mass)

Period	IA 1	II A 2	III B 3	IV B 4	V B 5	VI B 6	VII B 7	VIII 8	VIII 9	VIII 10	I B 11	II B 12	III A 13	IV A 14	V A 15	VI A 16	VII A 17	VIII A 18
1	1 **H** 1.01																	2 **He** 4.00
2	3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
3	11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
4	19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.71	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
5	37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** 98.91	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.40	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.30
6	55 **Cs** 132.91	56 **Ba** 137.33	57-71 **La-Lu**	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.20	77 **Ir** 192.22	78 **Pt** 195.09	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.37	82 **Pb** 207.20	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
7	87 **Fr** (223)	88 **Ra** (226)	89-103 **Ac-Lr**	104 **Rf** (261)	105 **Ha** (262)													

Period															
6	57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** 145	62 **Sm** 150.36	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
7	89 **Ac** 227.03	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** 237.05	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (254)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)