Question 1

Several levels of government and certain companies offer rebates on products that would help reduce one's ecological footprint.

Ms. Barba takes advantage of the following four rebates:

1. The city of Laval offers a $75 rebate for residents who install low flow, water-saving toilets in their homes.

2. Hydro-Quebec offers a mail-in rebate of up to $25 to replace incandescent light bulbs with more energy-efficient CFL or LED bulbs.

3. A local grocery store is promoting local, Quebec-grown produce by offering a 25% discount off the regular price.

4. A local car dealer offers a rebate of $1 000 to first-time car buyers.

Which of the above rebates would NOT help reduce Ms. Barba's ecological footprint?

    A)   1

    B)   2

    C)   3

    D)   4

Question 2

Cedric has decided to breed his pet mice. He knows that black fur colour is dominant to white fur colour in mice. Black mice get a higher price at the pet store.

He crosses a black mouse with a white mouse. He expected all the offspring produced to have black fur. However, he was disappointed to discover 4 white and 4 black mice in the litter.

What mistake did Cedric make?

   A)   He assumed that black alleles were more common than white.

   B)   He assumed that white alleles were more common than black.

   C)   He assumed that his black mouse was homozygous for black fur.

   D)   He assumed that his white mouse was homozygous for white fur.
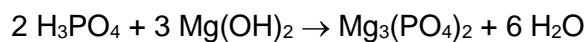
Question 3

Phosphorus, a basic component of DNA, is an element essential to life. Phosphorus is exchanged continually between the lithosphere, hydrosphere and biosphere through a series of transformations called the phosphorus cycle.

Which of the following transformations returns phosphorus to the biosphere?

   A)   Sedimentation in seas and oceans

   B)   Absorption by living organisms

   C)   Decomposition of waste

   D)   Dissolution in water

Question 4

The following balanced equation represents the neutralization reaction between phosphoric acid, H_3PO_4, and magnesium hydroxide, $Mg(OH)_2$:

$$2\ H_3PO_4 + 3\ Mg(OH)_2 \rightarrow Mg_3(PO_4)_2 + 6\ H_2O$$

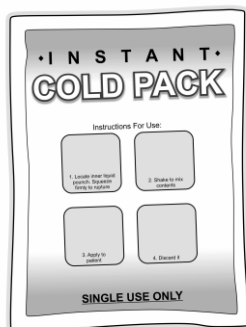In an experiment involving this reaction, 243 g of water were produced.

What mass of phosphoric acid was used?

A) 1323 g

B) 441 g

C) 147 g

D) 73.5 g

Question 5

Instant cold packs are used to treat athletic injuries. They contain solid ammonium nitrate, NH_4NO_3, and a bag of water.

Cold Packs

When the pack is squeezed, the bag of water breaks and the solid dissolves. This process quickly lowers the temperature of the pack below 0 °C.

Which of the following best describes this situation?

A) More energy is released than absorbed during the dissolution of NH_4NO_3.

B) The dissolution of NH_4NO_3 in water is an exothermic process.

C) $NH_4NO_{3(s)} + 25.7\ kJ \rightarrow NH_4NO_{3(aq)}$

D) $NH_4NO_{3(s)} \rightarrow NH_4NO_{3(aq)} + 25.7\ kJ$

Question 6

Karina decides to make herself some french fries as a snack. In order to cook her French fries, the temperature of the oil must be 190 °C. Karina pours 1.4 kg of oil, originally at a temperature of 23 °C, into a deep fryer. It takes 390 446 J of energy to heat the oil.

What is the specific heat capacity of the oil used?

      A)   1.67 J/(g•°C)

      B)   12.12 J/(g•°C)

      C)   1670 J/(g•°C)

      D)   12 120 J/(g•°C)

Question 7

Beryllium phosphide is a semiconductor used in laser diodes.

What is the chemical formula for beryllium phosphide?

      A) $Be_3(PO_4)_2$

      B) $BePO_4$

      C) Be_2P_3

      D) Be_3P_2

Question 8

Chlorine has two stable naturally occurring isotopes. They are identified by their atomic mass as follows: chlorine-35 which accounts for about 75% of all existing atoms and chlorine-34 which represents about 24%. The relative atomic mass of chlorine is 35.45 amu.

Below are some statements regarding the element chlorine.

1. Chlorine-35 and chlorine-34 are radioactive isotopes of the same element.

2. The relative atomic mass of chlorine is the same as the atomic mass of chlorine.

3. The atomic masses of the two atoms are different because the number of neutrons in their nuclei is different.

4. Chlorine-34 has one less proton than chlorine-35.

5. When combined with hydrogen, the two atoms form the same substance, HCl.

Which of the above statements are TRUE?

A) 1 and 3

B) 2 and 4

C) 3 and 5

D) 4 and 5

Question 9

Javier assembled the following circuit in the lab:

$V_T = 20.0$ V +

$I_T = 10.0$ A -

$R_1 = 5.0$ Ω $R_2 = 4.0$ Ω R_3
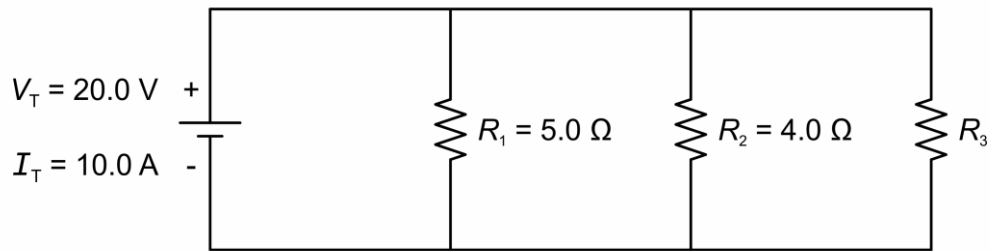
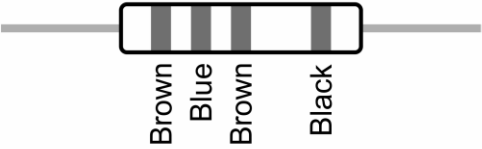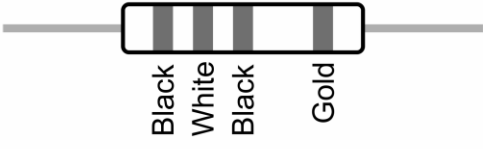**What is the current intensity flowing through resistor R_3?**
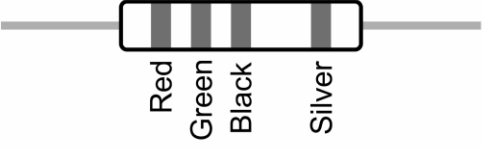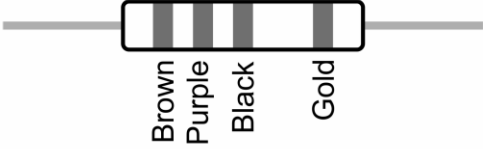
    A)   1.0 A

    B)   1.5 A

    C)   2.2 A

    D)   10.0 A

Question 10

Veronica has recently decided to install a dimmer switch to her living room lights. In order to do so, she needs a resistor with a resistance between 15 Ω and 25 Ω.

Which resistor should Veronica use?
Refer to the Resistor Colour Code Chart in Appendix 3.

A)
Brown Blue Brown Black

B)
Black White Black Gold

C)
Red Green Black Silver

D)
Brown Purple Black Gold

Question 11

A population of killer whales in the Gulf of St. Lawrence is listed as endangered under the Canadian Species at Risk Act. This species spends about half of the year foraging in inland waters and relies almost exclusively on salmon as prey. Recent data suggests that this killer whale population has declined by approximately 7% over the past four years.

The concentration of water contaminants (mercury, dioxins, PCBs etc.) has been steadily increasing in the last four years and traces of these contaminants were found in all species of plants and animals living in the Gulf of St. Lawrence.

Gulf of St. Lawrence Food Web
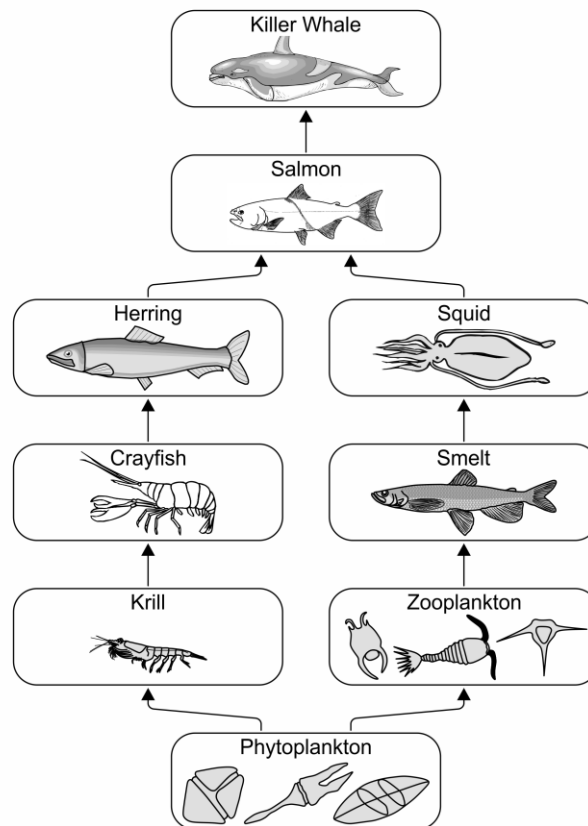
Using the information provided, give a possible explanation for the decline of this killer whale population.

Question 12

A new species of fly has been discovered and is being used in genetic research.

In one such research experiment, a female fly with red eyes was crossed with a male fly with black eyes.

The results of the cross were 400 offspring. Of the 400 offspring, 196 have red eyes and 204 have black eyes. Red eye colour is a recessive trait.

What is the genotype of each parent fly?
Explain your answer.

Question 13

Every year, thousands of Canadians participate in the Great Canadian Shoreline Cleanup. The goal of this country-wide activity is for volunteers to gather at different shorelines and pick up every piece of garbage in sight.

This initiative has been ongoing since 1994 and has helped promote an understanding about shoreline litter issues by educating and encouraging Canadians to rehabilitate shoreline areas through cleanups.

Name two soil or water pollutants (contaminants) that may be found on Canadian shorelines.
Explain their effect on the environment.

Question 14

Health Canada has considered imposing restrictions on the sale of energy drinks to minors because of the high concentrations of caffeine, $C_8H_{10}N_4O_2$, in these drinks.

One 245.0 mL can of an energy drink contains 76.5 mg of caffeine.

What is the molar concentration of caffeine in this energy drink?
Significant figures will be evaluated in the question.

Question 15

Nitrogen, N_2, gas is a main component of the atmosphere, representing about 78% of the air we breathe.

a) **What type of bond is formed in a molecule of N_2?**

b) **Represent how the electrons are involved in the bonding process.**

Question 16

Certain properties of elements and their descriptions are listed in the tables below.

Table 1 – Description

a)	Determines the physical and chemical properties of an element.
b)	A pattern that occurs across a period or within a group of the periodic table.
c)	In the same period, elements that have more protons in their nuclei tend to pull their electrons closer.
d)	Fluorine has a higher tendency to attract electrons than oxygen.
e)	The fewer electrons it has on the outermost shell, the more reactive a metal is.

### Table 2 – Property

1.	Electronegativity
2.	Atomic radius
3.	Electron configuration
4.	Chemical reactivity
5.	Periodic trend

Match the descriptions in Table 1 with the correct properties from Table 2.

Question 17

Brad is pulling his daughter Ashley on a sleigh. The rope is at an angle of 47° with the horizontal. Brad has a mass of 87 kg and exerts a force equal to his weight, and pulls his daughter for a total of 1.0 km.
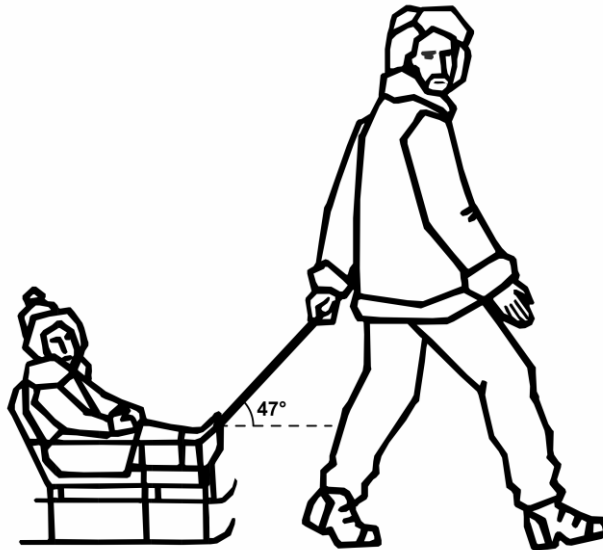
How much work is done by Brad?
Significant figures will be evaluated in the question.

Question 18

It is a known fact that kinetic energy is proportional to the braking distance of a car. In light of this fact, many municipalities have reduced the speed limit in residential areas from 50 km/h to 40 km/h.
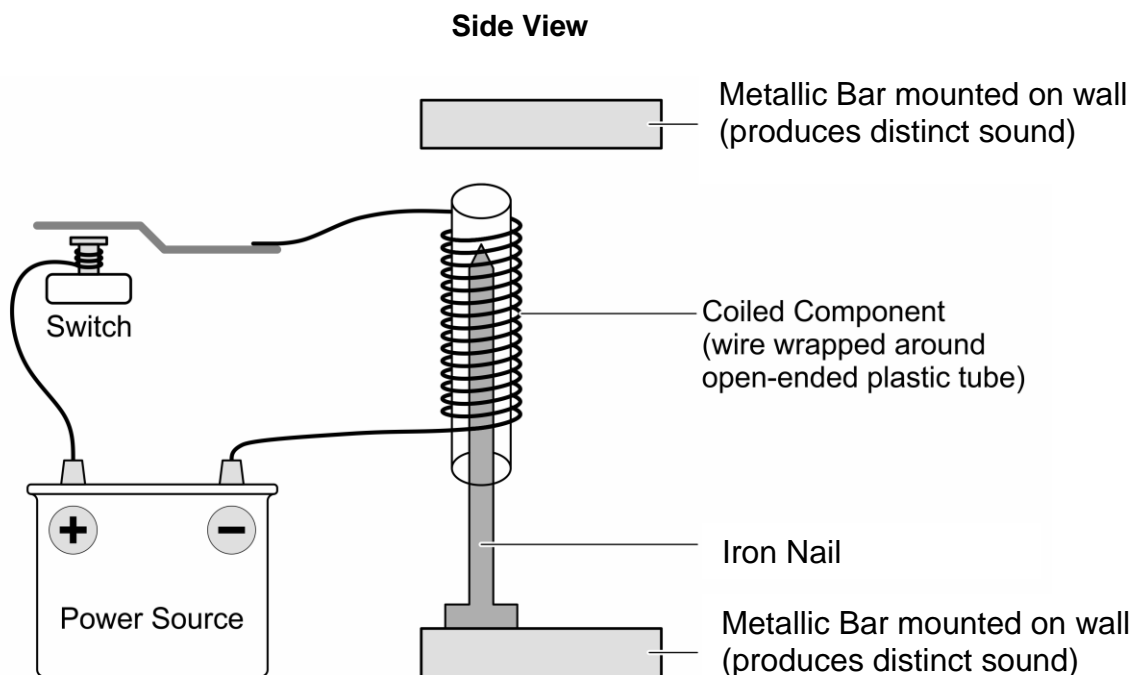
You wish to show scientifically that a decrease of 10 km/h would considerably reduce the kinetic energy and possible damage caused by a moving vehicle.

The averaged-sized car has a mass of 1500 kg.

What is the difference in kinetic energy between an average-sized car travelling at 50 km/h and one travelling at 40 km/h?

Question 19

As part of your final practical examination in Environmental Science and Technology class, you are asked to assemble a solenoid and mount the coiled component vertically on a wall with tape as seen in the diagram below. An iron nail is inserted into the solenoid and rests on a metallic bar.

Side View

Metallic Bar mounted on wall
(produces distinct sound)

Coiled Component
(wire wrapped around
open-ended plastic tube)

Iron Nail

Metallic Bar mounted on wall
(produces distinct sound)

Switch

Power Source

In your *Answer Booklet*,

a)   **Explain what happens when the switch is turned on.**

b)   **Explain what happens when the switch is then turned off.**

c)   **Suggest one way of increasing the electromagnetic field.**

d)   **Give an example of how this solenoid can be used in everyday life.**

Question 20

The wastewater treatment plant in Rivière-des-Prairies is one of the largest in North America. It treats 7.6 million cubic metres of wastewater per day, which represents the water used by two million people and 4000 companies.

The diagram below represents a facility used to perform the primary (physical) treatment of wastewater at the plant in Rivière-des-Prairies.

Primary Treatment of Wastewater
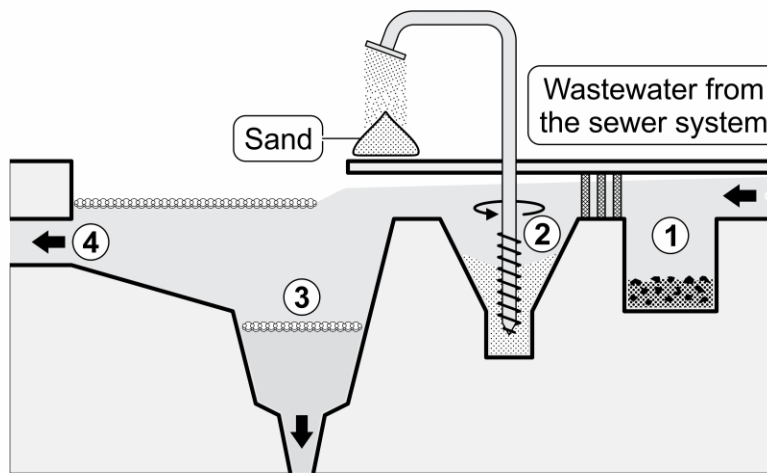
The table below lists the treatment processes, in no particular order.

Treatment Processes
Removal of sand and grit in a degritter
Transfer of wastewater into the secondary treatment unit
Screening wastewater for large pieces
Collecting organic matter in a tank in order for it to be removed

Match the numbers on the diagram with the correct description of the process they represent.

FORMULAS		
$C = \dfrac{m}{V}$	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

$R_{eq} = R_1 + R_2 + ...$ R_{eq}: equivalent resistance		$F_g = mg$ F_g: gravitational force
		          m: mass
		          g: gravitational field intensity

$\dfrac{1}{R_{eq}} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + ...$ 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
	Δt: change in time
		$E_k = \dfrac{1}{2}mv^2$ 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

$F_e = \dfrac{kq_1q_2}{r^2}$	F_e: electrical force k: Coulomb's constant q: charge of particle r: distance between two particles	

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

Resistor Colour Code 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

Tolerance: gold $\pm$ 5%, silver $\pm$ 10%, black $\pm$ 20%

PERIODIC TABLE OF THE ELEMENTS

Key

Element symbol

	Atomic number
1	
H	Atomic mass
1.01	

I A 1	II A 2					VIII B						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 H hydrogen 1.01																			2 He helium 4.00
3 Li lithium 6.94	4 Be beryllium 9.01													5 B boron 10.81	6 C carbon 12.01	7 N nitrogen 14.01	8 O oxygen 16.00	9 F fluorine 19.00	10 Ne neon 20.18
11 Na sodium 22.99	12 Mg magnesium 24.31	III B 3	IV B 4	V B 5	VI B 6	VII B 7	8	9	10			I B 11	II B 12	13 Al aluminum 26.98	14 Si silicon 28.09	15 P phosphorus 30.97	16 S sulphur 32.07	17 Cl chlorine 35.45	18 Ar argon 39.95
19 K potassium 39.10	20 Ca calcium 40.08	21 Sc scandium 44.96	22 Ti titanium 47.90	23 V vanadium 50.94	24 Cr chromium 52.00	25 Mn manganese 54.94	26 Fe iron 55.85	27 Co cobalt 58.93	28 Ni nickel 58.71	29 Cu copper 63.55	30 Zn zinc 65.39	31 Ga gallium 69.72	32 Ge germanium 72.59	33 As arsenic 74.92	34 Se selenium 78.96	35 Br bromine 79.90	36 Kr krypton 83.80		
37 Rb rubidium 85.47	38 Sr strontium 87.62	39 Y yttrium 88.91	40 Zr zirconium 91.22	41 Nb niobium 92.91	42 Mo molybdenum 95.94	43 Tc technetium 98.91	44 Ru ruthenium 101.07	45 Rh rhodium 102.91	46 Pd palladium 106.40	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.75	52 Te tellurium 127.60	53 I iodine 126.90	54 Xe xenon 131.30		
55 Cs caesium 132.91	56 Ba barium 137.33	57-71 lanthanoids	72 Hf hafnium 178.49	73 Ta tantalum 180.95	74 W tungsten 183.85	75 Re rhenium 186.21	76 Os osmium 190.20	77 Ir iridium 192.22	78 Pt platinum 195.09	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.37	82 Pb lead 207.20	83 Bi bismuth 208.98	84 Po polonium (209)	85 At astatine (210)	86 Rn radon (222)		
87 Fr francium (223)	88 Ra radium (226)	89-103 actinoids	104 Rf rutherfordium (267)	105 Db dubnium (268)	106 Sg seaborgium (271)	107 Bh bohrium (272)	108 Hs hassium (270)	109 Mt meitnerium (276)	110 Ds darmstadtium (281)	111 Rg roentgenium (280)	112 Cn copernicium (285)	113 Uut ununtrium (284)	114 Fl flerovium (289)	115 Uup ununpentium (288)	116 Lv livermorium (293)	117 Uus ununseptium (292)	118 Uuo ununoctium (294)		

6	57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium (145)	62 Sm samarium 150.36	63 Eu europium 151.96	64 Gd gadolinium 157.25	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.05	71 Lu lutetium 174.97
7	89 Ac actinium (227)	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium (237)	94 Pu plutonium (244)	95 Am americium (243)	96 Cm curium (247)	97 Bk berkelium (247)	98 Cf californium (251)	99 Es einsteinium (252)	100 Fm fermium (257)	101 Md mendelevium (258)	102 No nobelium (259)	103 Lr lawrencium (262)