CLIFTON
COLLEGE

13+ Scholarship Examination
Specimen Paper

Science

Time allowed: 60 minutes.

- **Calculators may be used**.
- The paper is divided into three sections: Biology Section A, Chemistry Section B, and Physics Section C.
- Answer all questions.
- Marks will be awarded for your working in calculations so please make sure you show these.

Total Marks = 48

First Name:.....

Surname:.....

Section A - Biology

1. An animal found in eastern parts of Canada and the US and seems to have evolved about 100 years ago is part wolf, part dog, part coyote. Although once rare, they are now numbered in their millions.
   The animal is a mammal.
   a. Give two characteristics which this animal shares with other mammals.

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      ……....(2)

   b. Scientists have compared the DNA of this animal with the DNA of a dog, a wolf and a coyote.
      The percentage DNA of these animals is approximately the following:

Animal	Percentage DNA
Coyote	65
Wolf	25
Dog	10

      The popular name for these animals is the ‘coywolf’.
      Discuss whether this is an appropriate name.

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      ……....(2)

c. Wolves like to hunt their prey in forests, but their numbers are declining because of changes to the environment.
Coywolves are skilled at hunting prey both in open terrain and in wooded areas.
Suggest reasons why in Canada, the number of coywolves has risen but the number of wolves has fallen.

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d. Coyotes and wolves are shy animals which do not live near to humans in towns. The coywolf on the other hand is beginning to colonise cities such as New York, Boston and Washington DC.
Using the information in this question, explain how the Biology of the coywolf might enable it to adapt to living in cities.

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e. The coywolf can breed successfully with other coywolves as well as coyotes, wolves and dogs. Discuss the evidence for and against calling the coywolf a new species.

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2. In 1648, Johann Baptist van Helmont reported the results of an important experiment on the growth of plants.
   He placed 90.9 kg of dry soil in a pot.
   Into this he planted a 2.3 kg willow shoot.
   He watered the plant.
   After five years he re-weighed the plant (which was not a tree).
   It weighed 77.0 kg.
   He also weighed the dry soil; it weighed 90.8 kg.

   Van Helmont's hypothesis was that the growth of the willow tree came only from the soil.

   a.
      i. Use the evidence to suggest the extent to which van Helmont's hypothesis is correct. Give an explanation in your answer.

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ii. Explain how scientists now believe that the growth of the willow tree occurred.

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Total marks for section = 16

Section B Chemistry

1. Silver Nitrate Solution is a clear, colourless liquid. Two reactions of silver nitrate are given below. If a chemical is in solution it is labelled (aq), (s) for solid.

   Reactions:

   1 Silver nitrate (aq) + copper (s) -> copper nitrate (aq) + silver (s)

   2 Silver nitrate (aq) + sodium chloride (aq) -> sodium nitrate (aq) + silver chloride (s)

   a.

      i. Name the type of reaction occurring in reaction 1.

      ……(1)

      ii. Suggest what the reaction tells you about the two metals.

      ……(1)

   b. Describe how you could collect a pure, dry sample of silver chloride solid from the result of reaction 2.

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      ……..(2)

Reaction 2 was formerly used in the manufacture of photographic plates which had a thin layer of white silver chloride on them.
An object could be put on the plate and then the whole setup exposed to bright light.
Silver chloride reacts to form silver and chlorine when exposed to bright light.

c.

i. Name the type of reaction which occurred when the plate was exposed to bright light.

…….. ……..…….(1)

ii. Explain how a similar reaction can be carried out for copper carbonate using a bunsen flame instead of bright light. Your explanation should include an equation to summarise the reaction as well as a description of how it would be undertaken in the laboratory.

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2. The element bromine is a dark red volatile liquid at room temperature.

    a. Explain what you understand by the word element.

……..(1)

    b. Some information about bromine is given in the table below.

Symbol	Br
Formula of the element	Br_2
Melting Point	-7^0C
Boiling Point	59^0C
Density	$3.1\ g/cm^3$

In the box below draw a diagram to show how the atoms are arranged in bromine at room temperature.

(2)

c. If the stopper were removed from a bottle of bromine, bromine vapour would spread into the air above the liquid.

i. Explain why bromine can evaporate at a temperature below its boiling point.

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……...(1)

ii. What is the name given to this spreading out of the bromine vapour?

……...(1)

d. Bromine will react with Potassium Iodide in a displacement reaction. Provide the word equation for this process and balanced symbol equation.

Word equation:

……...(1)

Balanced symbol equation

……...……(2)

Total marks for section = 16

Section C Physics

1. A simplified view of how the global positioning system (gps) works is that each of a network of satellites transmits a radio signal which gives the exact time transmitted and the position of the satellite at the instant of transmission.
   A gps receiver picks up the signal from at least three satellites and uses the time taken for the signal to reach the receiver, plus the position of the satellite when it sent the signal, to calculate the position of the receiver.
   A gps satellite is in orbit around 20200km above the surface of the Earth.
   Radio waves travel at 300 million m/s (3.0×10^8 m/s).

   a. Show that it takes about 0.07s for the radio signal from a satellite to reach the Earth immediately below it.

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   ……(2)

   b. The time signals are accurate to at least +/- 0.00000001s. Suggest why this means that good gps receivers can give a position to within about 3 metres.

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   ……..(3)

The signal from at least three satellites is needed to give an accurate position horizontally.

c. With the aid of a diagram, suggest and explain why the signals from three satellites are needed.

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……(3)

2. Many lights now use LED lamps.

The light output from a lamp is generally measured in lumens (lm), where a lumen is a measure of the total amount of visible light emitted by an object.
The table below shows the electrical power (in J/s or watt (W)) transferred to different types of lamp so that they all have the same light output of 800 lm.

Type of lamp	Electrical Power in J/s or W
Incandescent (filament) lamp	60
'Low energy' compact fluorescent lamp (CFL)	13
LED lamp	8

a. With reference to the data in the table, suggest why LED lamps are increasingly preferred over incandescent lamps or other 'low energy' lamps.

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……(2)

b. The efficacy of a lamp is measured as the number of lumens per watt. Show that the efficacy of an incandescent lamp is about 13 lm/W.

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c. Show that LED lamps are about 8 times more efficient than incandescent lamps.

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……(2)

d. Calculate the energy transferred when a 2kW bulb is used for 1 minute.

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……(2)

Total marks for section = 16

TOTAL MARKS FOR PAPER = 48