



UNIVERSITY OF BRITISH  
COLUMBIA  
Faculty of Science



**NSERC  
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Science

# Michael Smith National Science Challenge 2014

Tuesday, February 25th, 2014

9-10 Pacific, 10-11 Mountain, 11-12 Central, 12-1 Eastern, 1-2 Atlantic, 1:30-2:30 Newfoundland

**PLEASE PRINT DOUBLE-SIDED (BLACK AND WHITE OK)**

## ***Instructions***

1. Do not open this examination booklet until you are told to do so.
2. Be certain that you understand all of the instructions. If not, ask your teacher.
3. Do not ask your teacher for any help with the content of the examination.
4. This examination is closed-book. No notes of any kind (printed or electronic) are allowed.
5. You may use a calculator (graphing or scientific) and a ruler.
6. No computers, tablets, cellphones, or other wireless devices are allowed.
7. Write your answers in this exam booklet and hand it back to your teacher at the end.
8. This exam booklet consists of 6 questions on 10 pages, including this page of instruction. Check to make sure you have all the pages.
9. Print your name and other information clearly. Only those who do so can be counted as official contestants.
10. When your teacher instructs you to begin, you will have **60 minutes** to finish the examination.

## ***Scoring***

Full marks will be given to a student who demonstrates clear understanding of the science required by the question.

Partial marks will be given for partial understanding. There are no penalties for incorrect answers. The questions are not of equal difficulty. Remember we are challenging the best science students in Canada; it is possible that even the best papers may not achieve an overall score of 80%. This is meant to be tough!

## ***Teachers***

Please mail\* the following **2 items** to Michael Smith Challenge, Department of Physics & Astronomy, 6224 Agricultural Road, UBC, Vancouver, BC, V6T 1Z1 by the end of **Tuesday, February 25th, 2014**:

1. Students' exam booklets
2. A cheque payable to University of British Columbia, for \$5.00 per script returned (if paying by cheque) **OR** a printed receipt of your payment (if paid by credit card).

\* Canada Post regular mail; express/couriers *not* necessary.

## ***Contest Named in Honour of Dr. Michael Smith (1932-2000)***

UBC's 1993 Nobel Prize Winner

## ***Examination Committee***

Oliver Gadsby, Andrzej Kotlicki, Theresa Liao, and Chris Waltham, UBC Department of Physics & Astronomy

Susan Vickers, UBC Department of Chemistry

David Ng, Michael Smith Laboratories, UBC

## ***Translator***

Jean-François Caron and Oliver Gadsby, UBC Department of Physics & Astronomy

**TEAR OFF FRONT PAGE**

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NAME (PRINT) \_\_\_\_\_ SCHOOL \_\_\_\_\_

1	2	3	4	5	6	TOTAL
<b>/10</b>	<b>/10</b>	<b>/10</b>	<b>/10</b>	<b>/10</b>	<b>/10</b>	<b>/60</b>

1. Given the 4 pairs of nutrition labels below, match each pair to the options listed on the next page. Write the appropriate letter (a-h) in the spaces provided.

**Label 1A (per 140 g): \_\_\_\_**

<u>Amount</u>	<u>% Daily Value</u>
<b>Calories</b> 230	
<b>Fat</b> 5 g	<b>8 %</b>
Saturated 1 g	<b>7 %</b>
+ Trans 0 g	
<b>Cholesterol</b> 120 mg	
<b>Sodium</b> 104 mg	<b>4 %</b>
<b>Carbohydrate</b> 0 g	<b>0 %</b>
Fibre 0 g	<b>0 %</b>
Sugars 0 g	
<b>Protein</b> 43 g	
Vitamin A           1 %   Vitamin C       0 %	
Calcium             2 %   Iron               8 %	

**Label 1B (per 100 g): \_\_\_\_**

<u>Amount</u>	<u>% Daily Value</u>
<b>Calories</b> 300	
<b>Fat</b> 25 g	<b>38 %</b>
Saturated 10 g	<b>55 %</b>
+ Trans 0.5 g	
<b>Cholesterol</b> 65 mg	
<b>Sodium</b> 60 mg	<b>3 %</b>
<b>Carbohydrate</b> 0 g	<b>0 %</b>
Fibre 0 g	<b>0 %</b>
Sugars 0 g	
<b>Protein</b> 17 g	
Vitamin A           0 %   Vitamin C       0 %	
Calcium             0 %   Iron             15 %	

**Label 2A (per 250 mL): \_\_\_\_**

<u>Amount</u>	<u>% Daily Value</u>
<b>Calories</b> 160	
<b>Fat</b> 8 g	<b>12 %</b>
Saturated 5 g	<b>26 %</b>
+ Trans 0.2 g	
<b>Cholesterol</b> 30 mg	
<b>Sodium</b> 125 mg	<b>5 %</b>
<b>Carbohydrate</b> 12 g	<b>4 %</b>
Fibre 0 g	<b>0 %</b>
Sugars 12 g	
<b>Protein</b> 8 g	
Vitamin A           10 %   Vitamin C       0 %	
Calcium             30 %   Iron             0 %	

**Label 2B (per 250 mL): \_\_\_\_**

<u>Amount</u>	<u>% Daily Value</u>
<b>Calories</b> 90	
<b>Fat</b> 0 g	<b>0 %</b>
Saturated 0 g	<b>0 %</b>
+ Trans 0 g	
<b>Cholesterol</b> 5 mg	
<b>Sodium</b> 125 mg	<b>5 %</b>
<b>Carbohydrate</b> 13 g	<b>4 %</b>
Fibre 0 g	<b>0 %</b>
Sugars 13 g	
<b>Protein</b> 9 g	
Vitamin A           10 %   Vitamin C       0 %	
Calcium             30 %   Iron             0 %	

**Label 3A (per 71 g): \_\_\_\_**

<b>Amount</b>	<b>% Daily Value</b>
<b>Calories</b> 170	
<b>Fat</b> 2 g	<b>3 %</b>
Saturated 0.4 g	<b>2 %</b>
+ Trans 0 g	
<b>Cholesterol</b> 0 mg	
<b>Sodium</b> 350 mg	<b>15 %</b>
<b>Carbohydrate</b> 32 g	<b>11 %</b>
Fibre 4 g	<b>16 %</b>
Sugars 2 g	
<b>Protein</b> 7 g	
Vitamin A           0 %   Vitamin C           0 %	
Calcium             4 %   Iron                 10 %	

**Label 3B (per 71 g): \_\_\_\_**

<b>Amount</b>	<b>% Daily Value</b>
<b>Calories</b> 170	
<b>Fat</b> 1.5 g	<b>2 %</b>
Saturated 0.3 g	<b>2 %</b>
+ Trans 0 g	
<b>Cholesterol</b> 0 mg	
<b>Sodium</b> 340 mg	<b>14 %</b>
<b>Carbohydrate</b> 34 g	<b>11 %</b>
Fibre 1 g	<b>4 %</b>
Sugars 3 g	
<b>Protein</b> 6 g	
Vitamin A           0 %   Vitamin C           0 %	
Calcium             4 %   Iron                 20 %	

**Label 4A (per 355 mL): \_\_\_\_**

<b>Amount</b>	<b>% Daily Value</b>
<b>Calories</b> 160	
<b>Fat</b> 0 g	<b>0 %</b>
Saturated 0 g	<b>0 %</b>
+ Trans 0 g	
<b>Cholesterol</b> 0 mg	
<b>Sodium</b> 40 mg	<b>2 %</b>
<b>Carbohydrate</b> 42 g	<b>14 %</b>
Fibre 0 g	<b>0 %</b>
Sugars 42 g	
<b>Protein</b> 0 g	
Vitamin A           0 %   Vitamin C           0 %	
Calcium             0 %   Iron                 0 %	

**Label 4B (per 355 mL): \_\_\_\_**

<b>Amount</b>	<b>% Daily Value</b>
<b>Calories</b> 170	
<b>Fat</b> 0 g	<b>0 %</b>
Saturated 0 g	<b>0 %</b>
+ Trans 0 g	
<b>Cholesterol</b> 0 mg	
<b>Sodium</b> 25 mg	<b>1 %</b>
<b>Carbohydrate</b> 38 g	<b>13 %</b>
Fibre 0 g	<b>0 %</b>
Sugars 34 g	
<b>Protein</b> 2 g	
Vitamin A           0 %   Vitamin C           160 %	
Calcium             4 %   Iron                 0 %	

Pair possibilities (may be in reverse order):

- a. White Bread   and   b. Whole Wheat Bread
- c. Orange Juice   and   d. Carbonated Soft Drink
- e. Chicken Breast   and   f. Ground Beef
- g. Homogenized (3.25%) Milk   and   h. Skim Milk

2. There have been numerous scientific articles examining the breeding habits and population size of various organisms over the last few years. Many of the authors of these articles have noted significant and rapid changes in their breeding behaviour and large fluctuations in population sizes. While some populations are shrinking, others are thriving.

a) Can you think of a reason why these changes have occurred?

b) How might such changes in reproduction and replication of organisms affect humans?

Effect 1:

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Effect 2:

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Effect 3:

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Effect 4:

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3. Estimate how much noise (expressed in decibels, dB) could be made by 60,000 Edmonton Eskimos fans at Commonwealth Stadium when measured on the field with the fans an average of 80 m distant?

No prior knowledge of sound is needed to attempt this question; all you need to know is this:

- One person shouting can produce a noise level of 90 dB at 10 m, 84 dB at 20 m, and 78 dB at 40 m. Two people shouting together can produce a noise level of 93 dB at 10 m, 87 dB at 20 m, and 81 dB at 40 m. Four people shouting together can produce a noise level of 96 dB at 10 m, 90 dB at 20 m, and 84 dB at 40 m.

Marks will only be given if you show your reasoning.

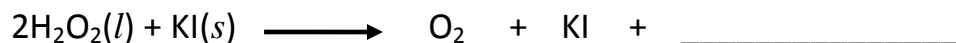
4. On August 6, 2012, NASA's *Curiosity* rover landed on the surface of Mars. One of the mission's goals was to look for water on the planet.

a) If you had to design an experiment to search for water on Mars, what properties of water would you use for the test?

b) How would you test these properties?

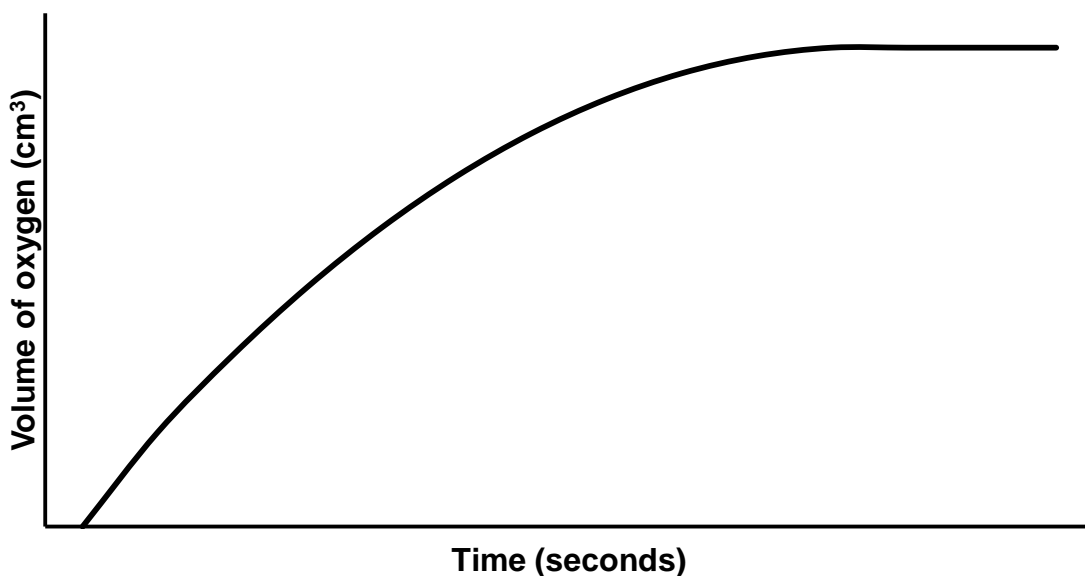
5. Hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) is a common chemical with many applications, including cleaning wounds and bleaching hair.

a) Fill in the missing product in the following decomposition reaction, and indicate the phase ( $s$  = solid,  $l$  = liquid,  $g$  = gas) of each product.



b) A catalyst increases the rate of a chemical reaction without being consumed. The following graph shows the uncatalyzed decomposition of hydrogen peroxide. Clearly draw on the graph the line you would expect to result from the catalyzed decomposition of hydrogen peroxide.

### Decomposition of Hydrogen Peroxide





- c) Draw a clearly labeled diagram of an experimental set up that could be used to measure the rate of decomposition of hydrogen peroxide.

6. A thin crescent moon is sometimes visible in the sky around dawn and dusk.

Imagine you are standing somewhere on the Earth at the time of one of the equinoxes (around March 21 or September 21). You see a crescent moon close to the horizon. Match the pictures I-IV with times and locations A-F and write the number of the picture in the boxes.

