a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA
Faculty of Science

UBC DEPARTMENT OF PHYSICS ASTRONOMY

Défi Scientifique Michael Smith Science Challenge

Wednesday, February 26th 2020

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 contest 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 contest.
4. This contest 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 booklet and hand it back to your teacher at the end.
8. This booklet consists of 4 questions on 8 pages, including this page of instruction.
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 contest.

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. We are challenging the strongest science students in Canada; it is possible that highest overall score will be less than 80%. This is meant to be tough!

Teachers

Please mail the following **two items** to Michael Smith Challenge, Department of Physics & Astronomy, 6224 Agricultural Road, UBC, Vancouver, BC, V6T 1Z1 by the end of **Wednesday, February 26th, 2020**:

1. Students' contest booklets
2. A cheque payable to "UBC Physics & Astronomy", for $6.00 per script returned (if paying by cheque) **OR** a printed receipt of your payment (if paid by credit card).

Please do not send by email.

Contest Named in Honour of UBC Professor Michael Smith (1932-2000)

Nobel Prize 1993, awarded for work on site-directed mutagenesis, the progenitor of gene therapies.

Contest Committee

Nikita Bernier (translator), Holden Jones, Theresa Liao, and Chris Waltham

TEAR OFF THIS PAGE

Do not hand in

TEAR OFF THIS PAGE and cut or tear to answer Q4.
Do not hand in this page

X

Y

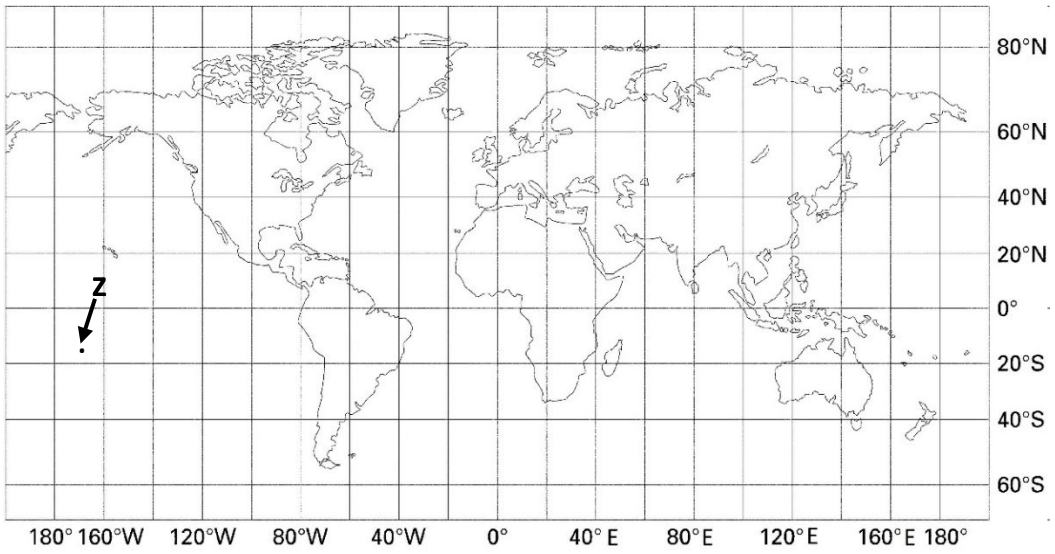
Z

Name (print):_____School_____

Time Started_____Finished_____

Q1 (20)	
Q2 (20)	
Q3 (20)	
Q4 (20)	
Σ (80)	

1. In January 2020, two people made an "Earth Sandwich", where they each placed a piece of bread on opposite sides of the Earth. One person was from place A (37° S, 175° E) and the other from place B (37° N, 5° W). We propose that the next Earth Sandwich will have one of its slices in Vancouver BC (49° N, 123° W).



a) On the map, clearly mark places A and B, and mark Vancouver with a "V". Use an arrowhead and dot to mark the positions, like position "Z" on the map.

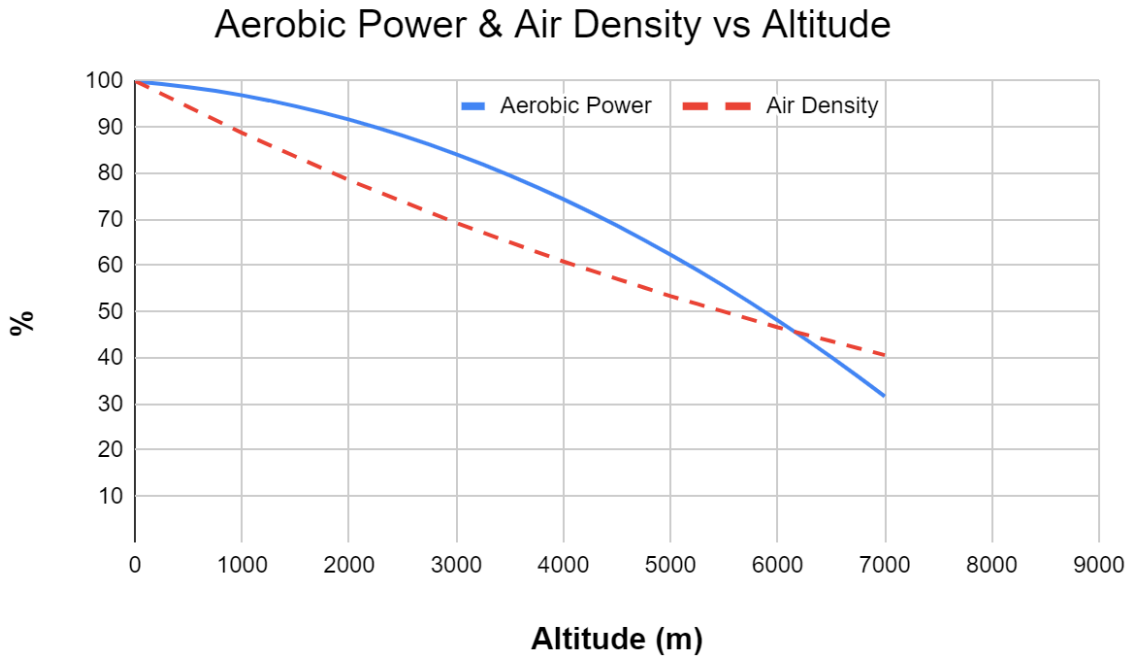
b) Give the coordinates of and mark on the map with an "X", the location that the slice opposite Vancouver should be placed. Give your answer in the box provided.

(_____ ° __ , _____ ° __)

c) For an earth sandwich starting somewhere in South America (x° S, y° W), give a formula in terms of x and y for the coordinate of the other slice. Give your answer in the box provided.

(_____ ° __ , _____ ° __)

2. The chart below shows the effects of altitude on air density and the aerobic performance of non-acclimatized athletes. Both datasets are scaled such that 100% corresponds to their respective values at sea level (0 m). Write your answers within the boxes below.



a) Briefly state the main reason why aerobic performance changes with altitude.

b) The 1968 Summer Olympics were held in Mexico City at an altitude of 2240m. At these games, a surprising number of world record times were set in high-speed track & field events. Why?

c) Estimate the optimal altitude for setting track and field world records. Briefly state why you chose that value.

d) Estimate how high one can climb without supplemental oxygen. Briefly state why you chose that value.

3. The Antarctic continent has an area 1/25 of that of the Earth's oceans; the mean thickness of the ice sheet covering it is 2 km. Icebergs float with 90% of their volume beneath the water level.

(a) If it all melts, make an estimate of the rise in global sea level. Use only the information given above and show your work.

(b) Write down up to four additional pieces of information that you would need to improve your estimate in (a). State their relevance to sea level rise. Please keep your writing inside the boxes.

New information	Relevance to sea level rise

4. (a) The chemical formula for wood is approximately $(CH_2O)_n$, where n is a large integer. Write balanced chemical equations for the following processes.

(i) Formation of wood:

(ii) Combustion of wood:

(b) Dendrochronology is the use of tree ring spacing to date wood. Distinctive ring patterns arise as a result of sequences of good and bad growing years. On the next page (p.8) are diagrams of complete cores taken from three trees (X, Y, Z) of about the same age, grown in the same forest but cut down in different years. The ring data have been corrected for all trees' natural tendency to grow faster when young than when they are old, i.e. if every year was the same as every other, all ring spacing would appear in the diagram to be the same. One tree has just been cut down (in 2020). Look at the tree rings and answer the following questions, marking your answers on the diagrams on the following page (p.8).

Note: these diagrams are repeated on p.2 of this exam; tear off and tear or cut up p.2 to allow comparisons to be made between the ring cores.

(i) Circle and mark with a “G” one 12-month period that was particularly good for growth

(ii) Circle and mark with a “P” one 12-month period that was particularly poor for growth

(iii) Mark in the boxes the year each tree was cut down

X

Y

Z

If you wish, make a brief comment on your answer in this box