UNIVERSITY OF
BRITISH COLUMBIA
Faculty of Science
Science One

NSERC CRSNG

promo Science

Michael Smith National Science Challenge 2010

Wednesday, March 24th, 2010

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

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 you are unsure about something, ask your supervisor.
3. This examination is closed-book. No notes of any kind (printed or electronic) are allowed.
4. You may use a calculator (may be a graphing calculator) and a ruler.
5. Write your answers in this exam booklet and hand it back to your teacher at the end.
6. This exam booklet consists of 6 questions on 10 pages; including this page of instructions and a data sheet. Check to make sure you have all the pages.
7. Print your name and other information clearly. Only those who do so can be counted as official contestants.
8. **Show your work.** Do rough work on the back of the paper.
9. 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 Prof. Chris Waltham, Department of Physics & Astronomy, 6224 Agricultural Road, UBC, Vancouver, BC, V6T 1Z1 before the end of **Thursday, March 25th, 2010**:
1. students' exam booklets
2. a cheque payable to University of British Columbia, for $5.00 per script returned.

* 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

Celeste Leander, UBC Department of Botany
Andrzej Kotlicki and Chris Waltham, UBC Department of Physics and Astronomy
Angela Ruthven, UBC Physics Outreach

Translator

Louis Deslauriers, UBC Department of Physics & Astronomy

"It is a small problem merely, but a problem that will agitate the little grey cells most adequately."
- Hercule Poirot

PLEASE TEAR OFF THIS FRONT PAGE

Data Sheet
Fiche de données

Relative Atomic Masses (1985 IUPAC)
*For the radioactive elements the atomic mass of an important isotope is given

Masses Atomiques Relatives (UICPA,1985)
*Dans le cas des éléments radioactifs, la masse atomique fournie est celle d'un isotope important

1																	18
1 H 1.008	2											13	14	15	16	17	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180
11 Na 22.990	12 Mg 24.305	3	4	5	6	7	8	9	10	11	12	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.07	17 Cl 35.453	18 Ar 39.948
19 K 39.098	20 Ca 40.08	21 Sc 44.956	22 Ti 47.88	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.905	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.08	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.03	89 Ac 227.03	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs	109 Mt									

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.4	63 Eu 151.97	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu
90 Th 232.038	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 (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

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NAME (PRINT): _____

SCHOOL: _____

GRADE: _____ PROVINCE: _____

DATE:_____

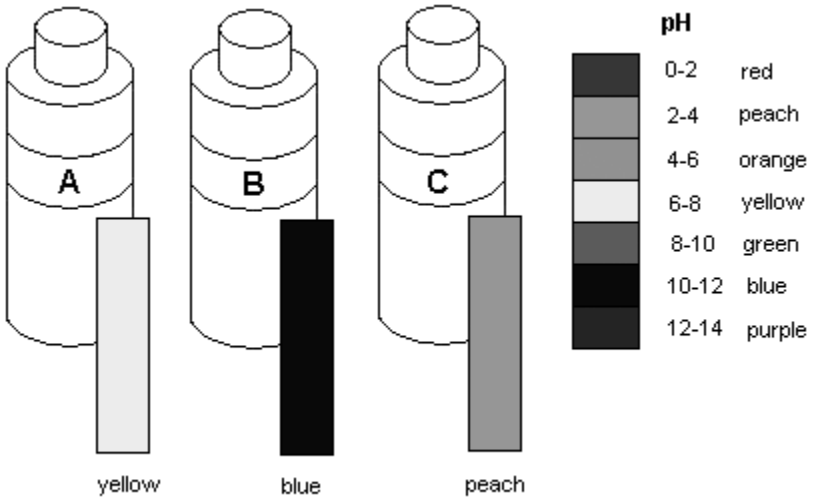
START TIME:_____

FINISH TIME:_____

Questions

1. (15 marks)
Peter discovers three unlabelled bottles of cleaning fluid in his house. He guesses that one is full of vinegar and that one contains ammonia (but doesn't know which is which). He has no idea what could be in the third.

a) Peter puts universal indicator paper in each solution, with the following results. Is it likely the solutions correspond to Peter's guesses? Which bottle is which?



ammonia:_____

vinegar:_____

b) Is the 3rd solution's identity known? Give reasons.

c) Can the 3rd solution be disposed of by pouring it down the drain? Give reasons.

2. (15 marks)
A star that can be seen from a given location at all hours of any clear night and never dips below the horizon is called “circumpolar.”

a) Where do you have to be on Earth for all the stars you can see in the sky at any given moment to be circumpolar?

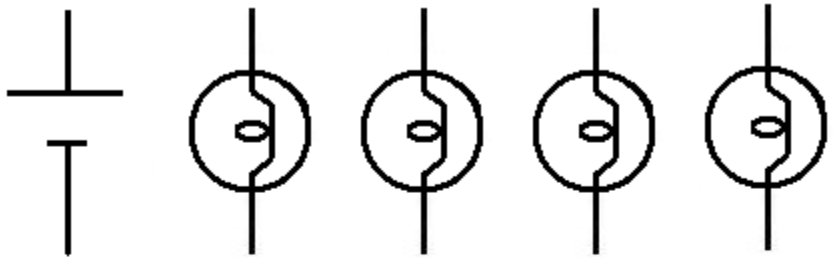
b) Are there any places where none of the stars that can be seen in the sky are circumpolar?

c) “Polaris,” the “pole-star” indicates the direction of true North. If you didn’t know anything about constellations and didn’t have a compass (or any other direction-finding means), how would you identify the pole-star?

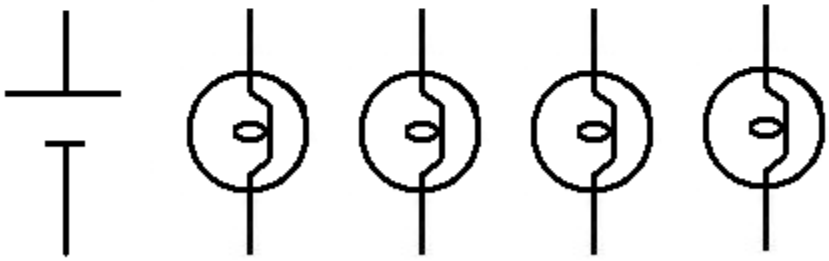
3. (5 marks each part)
You have two strings of Christmas lights, string A and string B. While hanging them up, one bulb on string A is smashed, causing all the lights in string A to stop working. A few minutes later, another bulb is smashed, this one from string B. You are surprised to find that the other lights in string B still work.

a) How are string A and string B wired? Show on the circuit diagram below.

String A

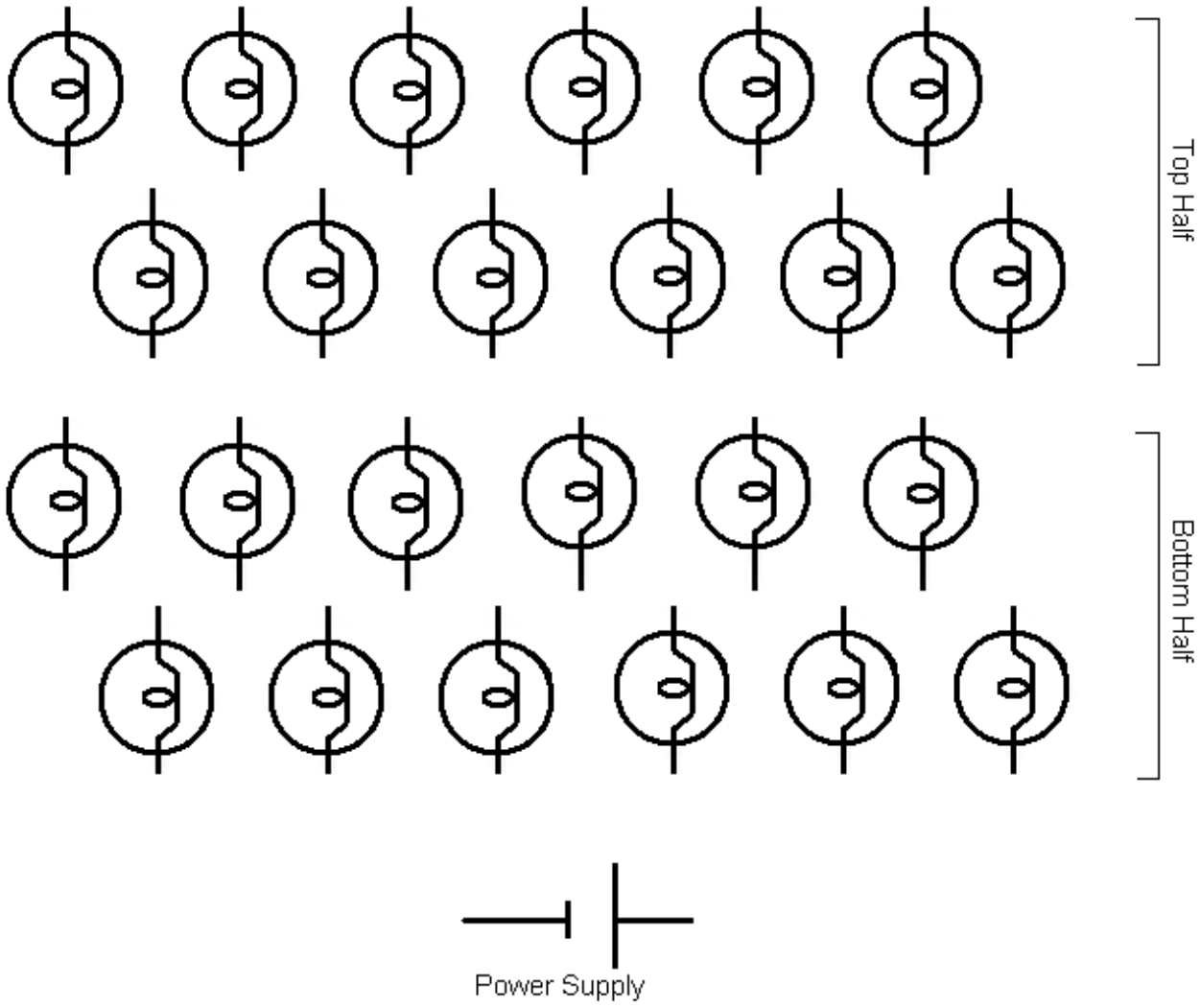


String B

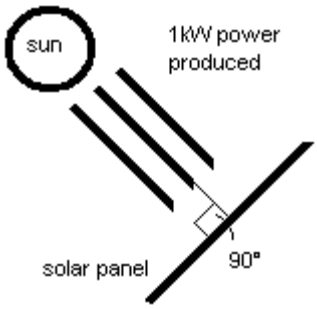


b) You find another set of lights, string C, which looks like a big net. When you remove a light bulb from the top half, all the lights in the top half go out, but the lights in the bottom half stay on. When you replace that light bulb and instead remove a light bulb from the bottom half, all the lights in the bottom half go out, and the lights in the top half stay on. How is string C wired? Show on the circuit diagram below.

String C

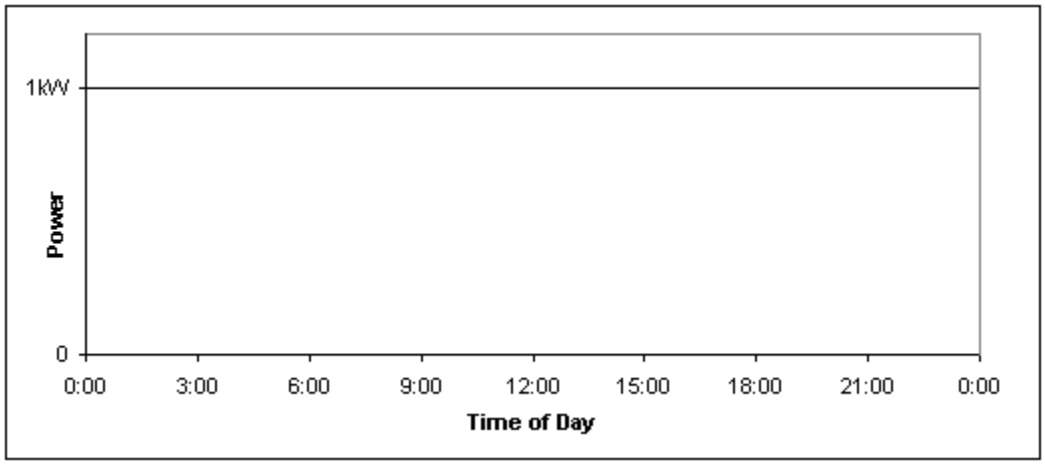


4. (5 marks each part)

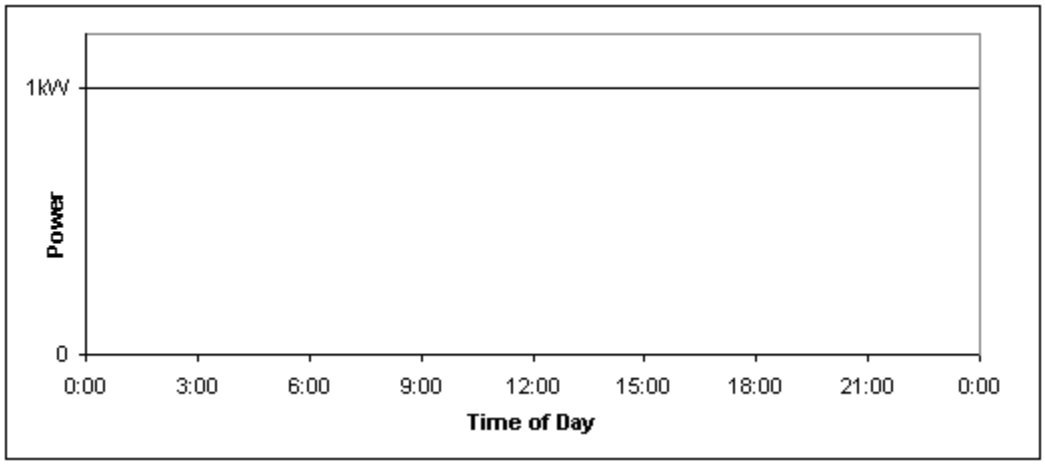


When an array of solar panels is positioned in such a way that sunlight hits it normally (with the sun's rays 90º to the surface of the panels), 1kW of power is produced. The panels are now placed horizontally on top of a flat roof of a home in a Canadian town. Sketch graphs of the power produced by the solar panel as a function of the time of day. Assume it is a clear day.

a) In June



b) In December

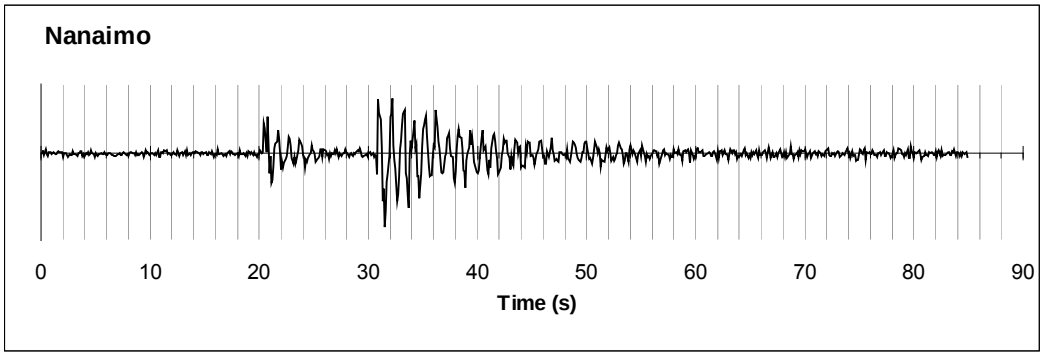


5. (15 marks)
A hypothetical ecosystem contains only 1 bird, and some number of insects and trees, which form a food chain. Using what you know about ecology, estimate the biomass of each species. Roughly how many insects and trees are in this system? Remember that living things are composed primarily of water. Show your work.

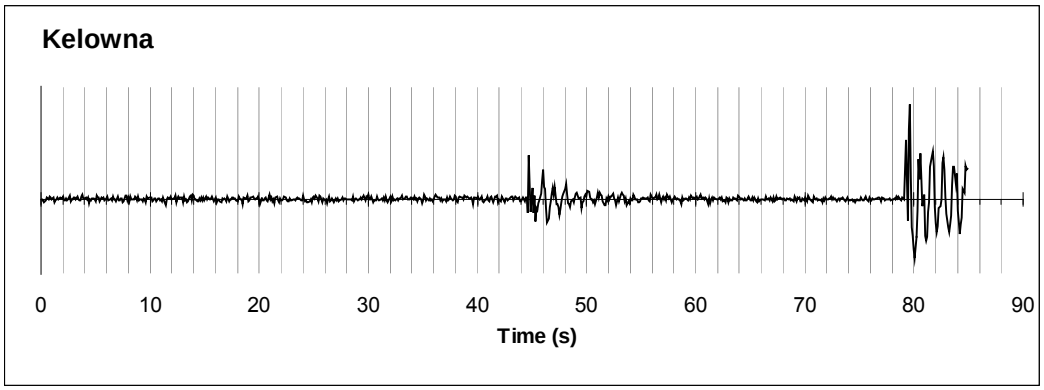
Density of Water
$\approx 1000\ kg/m^3$
$= 1\ kg/L$

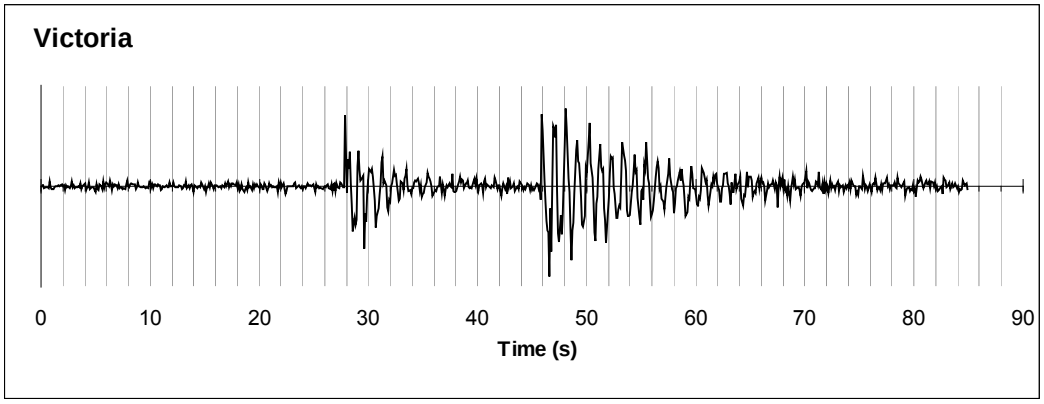
6. (15 marks)
Seismographs located in Nanaimo, Kelowna, and Victoria record an earthquake. In this region, assume s waves travel at 4000 m/s and that p waves travel at 8000 m/s.

a) Circle and label the p waves and s waves on the Nanaimo seismograph.
b) What time did the earthquake occur? Mark the time on the Nanaimo graph.

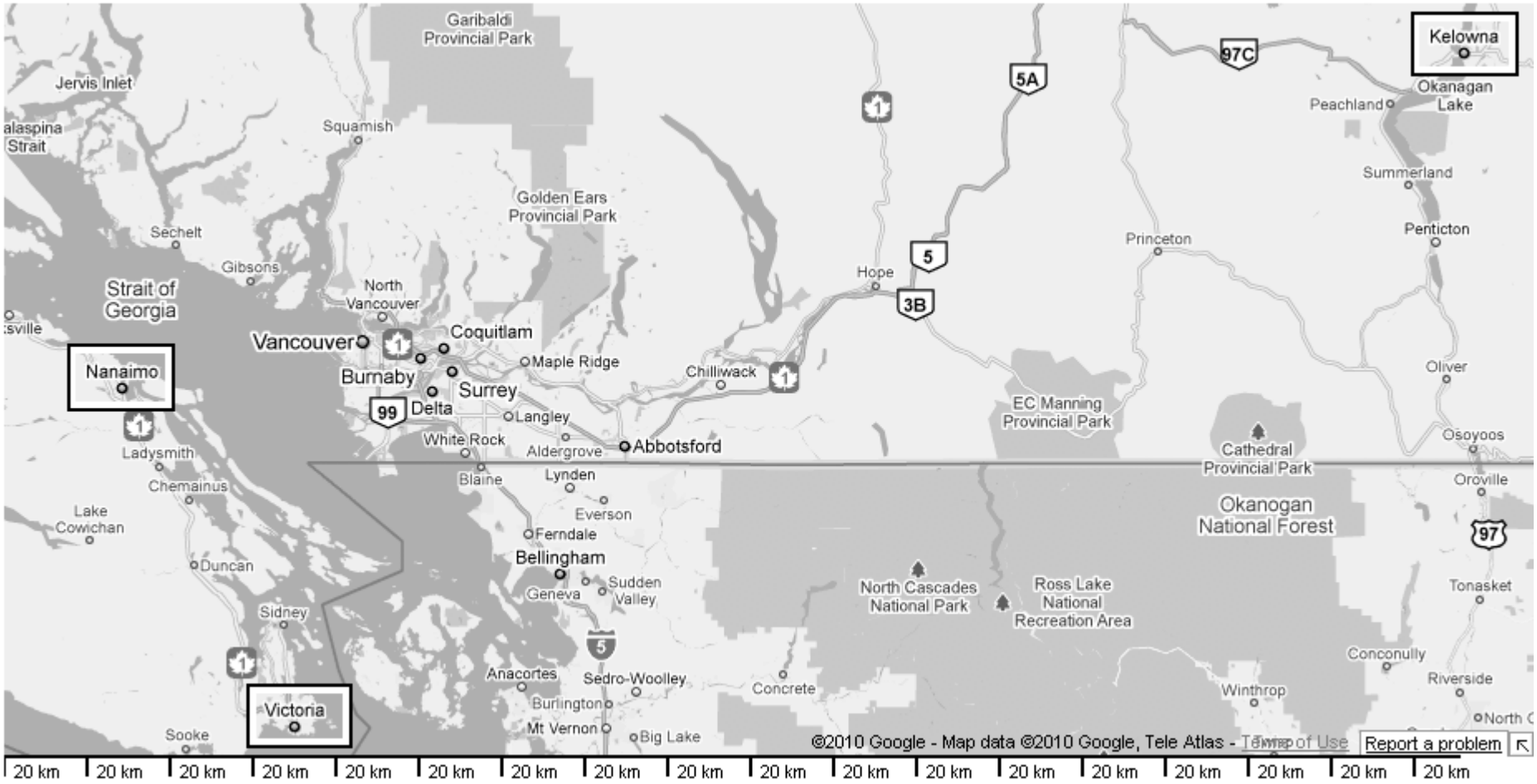


c) Where was the epicentre of the earthquake? Use all three seismographs. Feel free to draw on the map provided.





Note: The start time is the same for all three graphs.


Garibaldi Provincial Park
Jervis Inlet
Squamish
Golden Ears Provincial Park
Sechelt
Gibsons
Strait of Georgia
North Vancouver
Vancouver
Coquitlam
Burnaby
Surrey
Delta
Maple Ridge
Chilliwack
Hope
Princeton
Kelowna
Okanagan Lake
Peachland
Summerland
Penticton
Oliver
Osoyoos
Oroville
Nanaimo
Ladysmith
Chemainus
Lake Cowichan
Duncan
Sidney
Victoria
Sooke
White Rock
Blaine
Langley
Aldergrove
Abbotsford
Lynden
Everson
Ferndale
Bellingham
Sudden Valley
Geneva
Anacortes
Sedro-Woolley
Burlington
Mt Vernon
Big Lake
Concrete
EC Manning Provincial Park
Cathedral Provincial Park
Okanogan National Forest
North Cascades National Park
Ross Lake National Recreation Area
Winthrop
Conconully
Riverside
Tonasket
5A
97C
97
3B
99
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Report a problem
20 km