

 Défi Scientifique
Michael Smith
Science Challenge

Wednesday, February 15th 2017

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 examination.
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 exam booklet and hand it back to your teacher at the end.
8. This contest booklet consists of 4 questions on 6 pages, including this page of instruction. 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 strongest science students in Canada; it is possible that the 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 15th, 2017**:

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).

* Canada Post regular mail; express/couriers *not* necessary. Please do not send by email.

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

UBC's 1993 Nobel Prize Winner

Contest Committee

Nikita Bernier, Theresa Liao, Vitor Tiepo and Chris Waltham, UBC Department of Physics & Astronomy

Translator

Nikita Bernier, UBC Department of Physics & Astronomy

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Useful Information



Element	Symbol	Atomic Mass
Hydrogen	H	1
Carbon	C	12
Oxygen	O	16

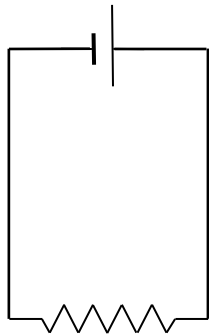
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NAME (PRINT) _____ SCHOOL (PRINT) _____

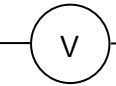
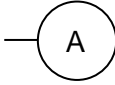
DATE AND TIME CONTEST STARTED (IF DIFFERENT THAN 09:00, FEB15) _____

Q1	Q2	Q3	Q4	Total
/20	/20	/20	/20	/80

1. Below is a circuit diagram of a battery  connected to a resistor .



Add to the circuit:

- a voltmeter , which measures voltage (V , in volts)
- a current meter (ammeter) , which measures current (I , in amps)

and say how you would measure the power (P , in watts) dissipated by the resistor.

2. On November 29, 2016, the Government of Canada granted approval for the Trans Mountain Expansion Project which will have the capacity to move 890,000 barrels of oil ($140,000 \text{ m}^3$) per day from Edmonton, AB to Burnaby, BC. The hydrocarbons to be transported – diluted bitumen and oils - have a typical density of 0.9 tonnes/m^3 and a carbon content of 90% by mass.

When this material is delivered to customers and burnt, estimate how many tonnes of carbon dioxide (CO_2) per year will be dumped in the atmosphere as a result. Assume the pipeline operates at full capacity, and no carbon is lost except by burning.

Note: Occasionally end-users employ small-scale carbon capture and storage, but this is mostly to produce CO_2 for industrial use or for soft-drinks, and thus the CO_2 will end up in the atmosphere anyway.

3. NASA has recently revealed plans to establish a colony on Mars. If this happens, communication with Earth will be an essential aspect of this mission, and timing will be crucial when sending signals to Mars Base.

Earth and Mars travel around the Sun in approximately circular orbits, with radii 1 AU* and 1.5 AU respectively. Light takes about 8 minutes to travel from the Sun to the Earth. How long will it take to transmit a short greeting "Hello" to Mars and receive a "Hello" back, assuming the colonists reply immediately?

* AU = astronomical unit (of distance).

4. (a) Use the following words/phrases to fill in the gaps in the paragraph below:

- cooler, energy, evaporation, food, less than, mechanical work, more than, sunshine, the same as, warmer, water

You may use a word/phrase more than once.

Human beings are homeotherms; i.e. our biology requires that we maintain a constant core temperature. Like all living things we are constantly exchanging _____ with our environment. As our cores are neither heating up nor cooling down, we know that for a given period of time, the amount of _____ we gain from the environment must be _____ the amount of _____ we lose to the environment. We gain _____ from _____, _____, and, if our surroundings are _____ than our skin, heat from the environment. We lose _____ to _____, _____, and, if our surroundings are _____ than our skin, heat to the environment.

(b) The metabolic rate (rate of energy use) in mammals does not scale with mass. That is, mammal A, 100 times more massive than mammal B, uses much less than 100 times the energy per day as mammal B (actually about 30 times). Suggest a reason for this.