THE UNIVERSITY OF BRITISH COLUMBIA

Science 1 Math/Phys

First Midterm

13 October 1999

TIME: 50 MINUTES

FULL NAME: ____________________ STUDENT # : ____________________

SIGNATURE: ____________________

This Examination paper consists of 6 pages (including this one). Make sure you have all 6.

INSTRUCTIONS:

Write your name on every page.

No memory aids allowed.

MARKING:

Q1	/30
Q2	/40
Q3	/30
TOTAL	/100

NAMES OF INSTRUCTORS: Mark MacLean, Jess H. Brewer & Domingo Louis-Martinez

Q1 Mathematics [30 marks]

(a) Evaluate $\displaystyle\lim_{x\to 2} \frac{x^2+x-6}{x^2-5x+6}$.

(b) If f is differentiable and $\displaystyle\lim_{x\to 1} \frac{f(x)-3}{x-1} = 4$, find $f(1)$ and $f'(1)$.

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(c) Compute $h'(0)$ if $h(x) = x^2 g(\sin(x))$, $g(0) = 1$ and $g'(0) = 2$.

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Q2 Viscous Drag [40 marks]

When an object moves through a fluid such as air, the flow of the fluid over its surface may be either *laminar* or *turbulent*. In *laminar* flow, the resulting friction of the fluid on the object produces what is known as *viscous drag*, in which the frictional force F_f of the fluid on the object is *proportional to the object's velocity* v through the fluid: $F_f = -\kappa\, v$, where κ is a constant. (The $-$ sign indicates that the friction force opposes the object's motion, as usual.)

A 100 kg cart is moving in the x direction along a perfectly horizontal road. There is *no friction* between the cart and the road, but the air exerts a *viscous drag* force on the cart with force constant $\kappa = 10$ N-s/m. The cart passes the point $x = 0$ at $t = 0$ with a velocity (in the x direction) of $v_0 = 10$ m/s.

(a) **Plot** the *acceleration* of the cart *vs.* the *velocity* of the cart.

(b) What is the *velocity* of the cart as a function of time?

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(*c*) **Plot** the x *position* of the cart *vs.* time.

Q3 Molecular Isomers [30 marks]

The *cis* isomer of a certain molecule has an intrinsic energy 4.1421×10^{-21} J higher than the *trans* isomer of the same molecule. If a large number of these molecules is in thermal equilibrium at a temperature of 300 K, *what fraction will be found in the cis state?*

[You may need Boltzmann's constant, $k_{\mathrm{B}} = 1.3807 \times 10^{-23}$ J/K.]

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