Version A

Student name (please print): _____

ID#: _____

UNIVERSITY of GUELPH

DEPARTMENT OF PHYSICS

PHYS*1020 INTRODUCTORY PHYSICS
FINAL EXAMINATION – FALL 2004

Examiner: J. O'Meara

TIME = 2.0 hr

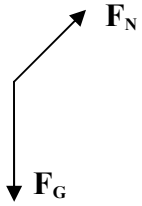
Please read the following instructions:

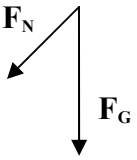
1. **Do not start the examination until you are instructed to do so.**
2. Allowed aid: calculator.
3. The last page gives a list of equations; you may remove that page if you wish.
4. There are 15 multiple choice questions and 4 problems. The exam booklet is 11 pages long: make sure you have a complete examination before you begin. **Contact an invigilator if you do not have a complete examination paper.**
5. On the computer answer sheet, use an **HB (or #2) pencil** to "bubble in"
   - your **name**
   - your **7-digit ID#**
   - your **answers** to the multiple choice questions
     (leave the "**Section**" number blank)
6. Write your problem solutions in detail on the blank spaces below the problems. Your solution must make clear what your symbols mean, where you started, what you did, and why you did it.
7. When you have completed the examination, hand in all question sheets and the computer answer sheet.
8. Total marks: 70 (Allot your time accordingly.)

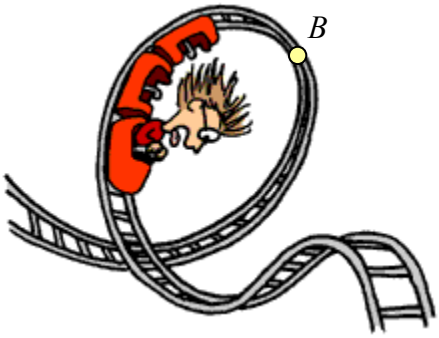
For marker's use:	
#16:	_____
#17:	_____
#18:	_____
#19:	_____
Problems total:	_____

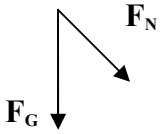
Part A: Multiple Choice (2 marks each – no part marks; total of 30 marks.)
Enter your answers on the computer answer sheet provided, using an HB pencil.

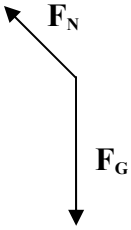
1. On a loop-the-loop roller coaster, the coaster at any instant follows a path that can be considered part of a circle. At the location marked *B* on the track, what is the correct free body diagram for the roller coaster? Neglect friction and air resistance.

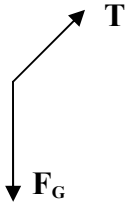
a) 

b) 

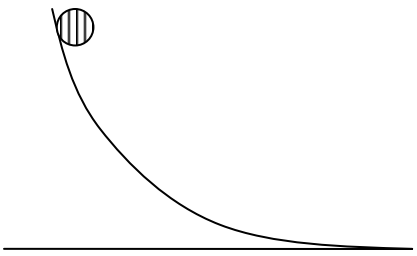


c) 

d) 

e) 

2. In the figure below, as the ball rolls down the hill:

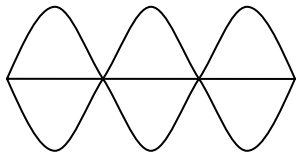


a) its speed increases and its acceleration decreases
b) its speed decreases and its acceleration increases
c) both speed and acceleration increase
d) both speed and acceleration remain constant
e) both speed and acceleration decrease

3. Consider red light of wavelength 633 nm, and green light of wavelength 537 nm. Which of the following statements is true?
   a) A photon of red light always has more energy than a photon of green light.
   b) A photon of red light always has less energy than a photon of green light.
   c) A photon of red light always has the same energy as a photon of green light.
   d) A photon of red light can have more energy, less energy, or the same energy as a photon of green light. It depends on the relative brightness of the red light and the green light.
   e) A stoplight emits light of wavelength 537 nm.

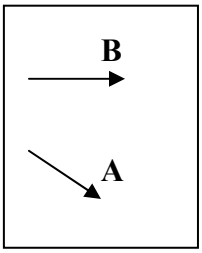
4. A guitar string (0.36 m long) produces a wave that travels at 99 m/s in the string when it vibrates in the third harmonic. What is the frequency of the wave generated?

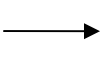
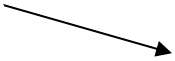
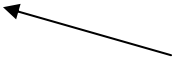
   a) 275 Hz
   b) 413 Hz
   c) 550 Hz
   d) 688 Hz
   e) 825 Hz



5. An automobile starts with an initial displacement from home of 3400 m north. The car is driven for 12 minutes, with a final displacement from home of 5900 m south. What was the average velocity of the car during this time interval in km/h?
   a) 47 km/h (south)
   b) 47 km/h (north)
   c) 13 km/h (south)
   d) 13 km/h (north)
   e) 65 km/h (south)

6. Shown to the right are two vectors, **A** and **B**. Which of the drawings below best represents the vector **B** – **A**?



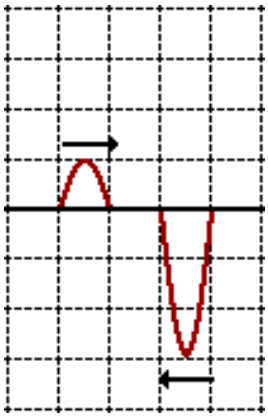
   a) 
   b) 
   c) 
   d) 
   e) 

7. A telecommunications satellite is traveling at constant speed in a circular orbit around Earth. Earth is exerting a gravitational force on the satellite, so why does the satellite not fall and crash into the Earth?
   a) the satellite is weightless
   b) the force of gravity is very, very weak at the height of the satellite
   c) the satellite is constantly being propelled by a rocket engine
   d) the satellite goes very fast, and the Earth's surface is curved
   e) the satellite is attracted toward the sun and the moon

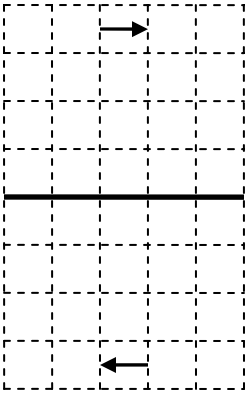
8. 2.76 eV photons shine through a diffraction grating with 850 lines/mm. At what angle do you expect to observe the 2nd maximum from the centre in this diffraction pattern?
   a) 25˚ b) 35˚ c) 64˚ d) 50˚ e) unobservable

9. A gun (mass = 6.1 kg) recoils when it fires a bullet. If the gun exerts a force of 1.1×10^4 N on the bullet (mass = 12 g), the initial acceleration of the recoiling gun is:
   a) 1.1×10^4 m/s^2 b) 9.2×10^5 m/s^2 c) 1.8×10^3 m/s^2
   d) 0 m/s^2 e) not enough information provided

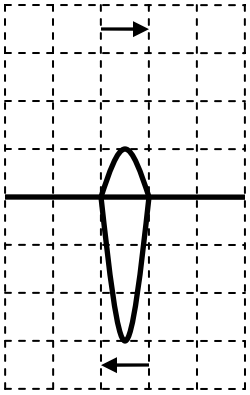
10. Use the principle of superposition to determine the wave that results from the combination of the two waves in the following diagram when they completely overlap.



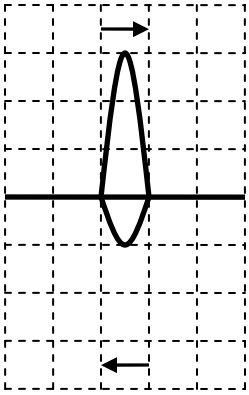
a)



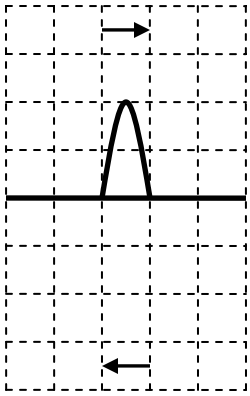
b)



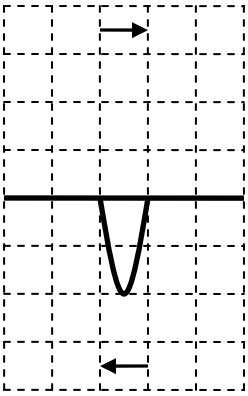
c)



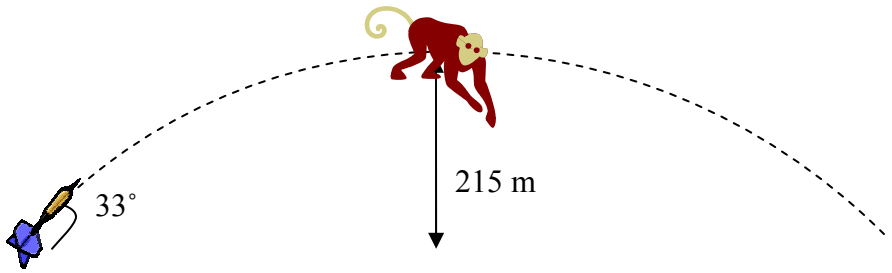
d)



e)



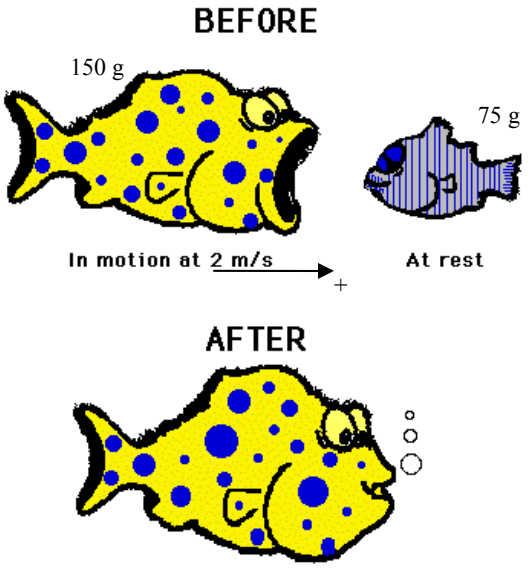
11. You are doing research in the rain forest in southern Brazil, and spot a Howler monkey up in a tree ahead of you. The monkey is 215 m above the ground. In order to study the monkey, you need to hit it with a tranquilizer dart. You aim your dart gun 33˚ to the horizontal and fire from ground level. What speed does the dart need to leave the gun in order to just reach the monkey? (*i.e.* assume that the dart reaches the monkey when the dart is at its highest point in its path)



a) 65 m/s b) 77 m/s c) 120 m/s d) 150 m/s e) 175 m/s

12. A large fish is moving at +2.0 m/s when it encounters a smaller fish which is at rest. The large fish swallows the smaller fish and continues in motion. If the large fish has a mass of 150 g, and the smaller fish has a mass of 75 g, then what is the speed of the fish after the "collision"? (Neglect frictional effects.)

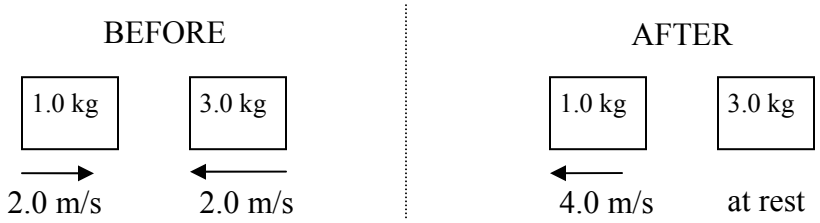
a) -1.6 m/s
b) -1.3 m/s
c) 0
d) 1.3 m/s
e) 1.6 m/s



In motion, fish moving together with the same speed

13. A snowflake is drifting down to the ground at constant velocity. The net (resultant) force on the snowflake is:
    a) the force of gravity, downward
    b) downward, but smaller than the force of gravity
    c) upward and equal in magnitude to the force of gravity
    d) downward, but larger than the force of gravity
    e) zero

14. From the figure below, determine the nature of this collision. The masses of the blocks and the velocities before and after are given. (Neglect frictional effects.) The collision is:
    a) elastic
    b) inelastic
    c) completely inelastic
    d) characterized by an increase in kinetic energy
    e) not possible because momentum is not conserved



15. A 15 kg box is sitting stationary on a horizontal floor (μ_s = 0.61 and μ_k = 0.29). A horizontal force of magnitude 72 N is applied to the box, but the box does not move. While the 72 N force is being applied, the static friction force acting on the box must have a magnitude:

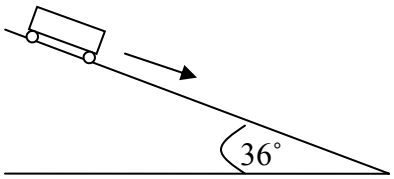
    a) 90 N
    b) 72 N
    c) 43 N
    d) 18 N
    e) 147 N

Name: _____

Part B: Problems – write your solutions in the space provided.

16. [10 marks] The roller coaster called the Bat (at Canada's Wonderland) starts when the coaster travels down an inclined plane at 36˚ to the horizontal.

a) [2 marks] Draw the free body diagram for the coaster on the incline (neglect friction).



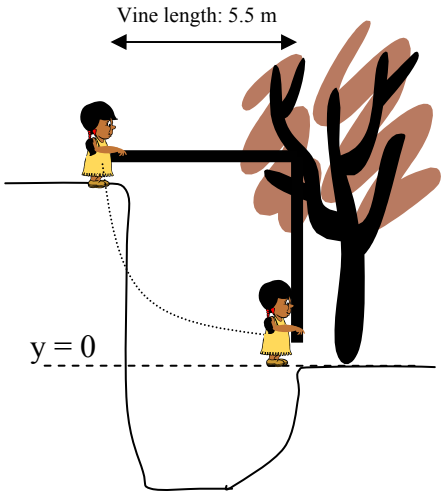
b) [4 marks] Neglecting friction, what is the acceleration of the coaster down the ramp?

c) [4 marks] If the ramp is 75 m long, how fast is the coaster moving when it gets to the bottom? Assume the coaster starts from rest.

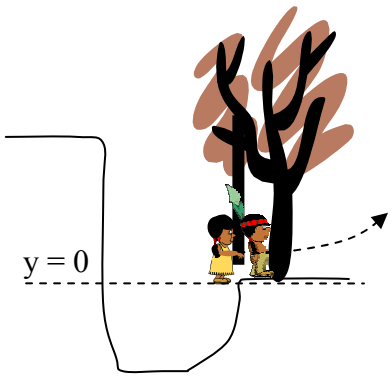
Name: _____

17. [10 marks] Jane (mass = 58 kg) is standing on a ledge, holding a vine horizontally, which is attached to a tree on the opposite side of the canyon. (see figure below) The vine is 5.5 m long. Ignore air resistance. The vine does not stretch.

a) [3 marks] If Jane starts from rest, use conservation of energy methods to determine her speed at the bottom of the swing.



b) [3 marks] If Jane collides with Tarzan (at rest, with mass = 76 kg) at the bottom of the swing, and they swing off together on the vine, what is their speed immediately after the collision? (If you did not get a value in a), assume a reasonable value for Jane's speed at the bottom of the swing and continue.)

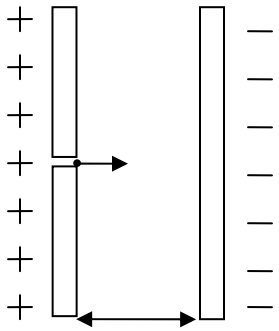


c) [4 marks] Use conservation of energy methods to determine the maximum height that Jane and Tarzan reach in their swing. (If you did not get a value in b), assume a reasonable value and continue.)

Name: _____

18. [10 marks] An electron (mass = 9.11 x 10^{-31} kg) with a velocity of 4.2 x 10^{5} m/s (right) enters a region of uniform electric field of magnitude 130 V/m. The plates creating the field are 1.0 cm apart as shown.

a) [2 marks] Draw the electric field lines associated with these plates.



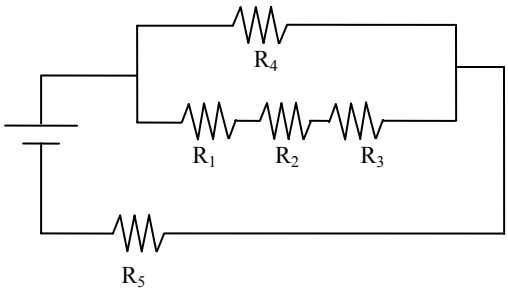
1.0 cm

b) [2 marks] What is the potential difference between the plates?

c) [6 marks] How far does the electron travel before momentarily stopping as it reverses direction?

Name: _____

19. [10 marks] In the circuit shown to the right, the current through resistor R_5 is 0.032 A.
R_1 = 14 Ω, R_2 = 7.5 Ω, R_3 = 21 Ω, R_4 = 18 Ω and R_5 = 32 Ω.



a) [4 marks] What is the equivalent resistance of the circuit?

b) [4 marks] Determine the rate of energy used by resistor R_4.

c) [2 marks] What is the potential difference across the terminals of the battery?

REMINDER: before you hand it in, make sure you have marked your name, id #, and answers to multiple choice questions on the provided answer sheet. Also, write your name on this exam booklet, at the top of each page. Hand in your answer sheet and this booklet.

Version A

EQUATIONS

$v = v_o + at$ $\quad x = x_o + \frac{1}{2}(v_o + v)t$ $\quad x = x_o + v_o t + \frac{1}{2} at^2$

$v^2 = v_o^2 + 2a(x - x_o)$ $\quad g = 9.8\ m/s^2$ $\quad a_c = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2} = 4\pi^2 r f^2$

$\Sigma \mathbf{F} = \mathbf{F}_R = m\mathbf{a}$ $\quad F_{s,max} = \mu_s F_N$ $\quad F_K = \mu_k F_N$

$W = F \Delta r \cos\theta = F_x \Delta x + F_y \Delta y$

$W_{tot} = \Delta E_k$ $\quad E_K = \frac{1}{2} m v^2$ $\quad E_p = mgy$ $\quad P = \frac{E}{t}$

$\vec{p} = m\vec{v}$ $\quad \Delta\vec{p} = \vec{F}_R \Delta t$

$F = \frac{G m_1 m_2}{r^2}$ $\quad G = 6.67 \times 10^{-11}\ N\ m^2/kg^2$ $\quad g = \frac{GM}{r^2}$

$F = \frac{k|q_1 q_2|}{r^2}$ $\quad k = 8.99 \times 10^9\ N\ m^2/C^2$ $\quad e = 1.60 \times 10^{-19}\ C$

$E = \frac{k|q|}{r^2}$ $\quad \vec{F} = q\vec{E}$ $\quad U = q|\vec{E}|\, y$ $\quad |\vec{E}| = \frac{\Delta V}{\Delta y}$

$V = \frac{U}{q}$ or $U = qV$ or $\Delta U = q \Delta V$

$I = \frac{q}{t}$ $\quad \Delta V = I R$ $\quad R = R_1 + R_2 + R_3 + \ldots$ $\quad \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$

$P = (\Delta V) I$ or $P = I^2 R$ or $P = \frac{(\Delta V)^2}{R}$

Version A

$$f = \frac{1}{T} \qquad v = \frac{\lambda}{T} \qquad \text{or} \qquad v = f\,\lambda$$

$P.D. = M\lambda$ where $M = 0, 1, 2, \ldots$ $\qquad P.D. = \left(N - \frac{1}{2}\right)\lambda$ where $N = 1, 2, 3, \ldots$

$\sin\theta = \frac{M\lambda}{d}$ where $M = 0, 1, 2, \ldots$ $\qquad \sin\theta = \frac{\left(N - \frac{1}{2}\right)\lambda}{d}$ where $N = 1, 2, 3, \ldots$

$$E_n = -\frac{2\pi^2 e^4 m k^2}{n^2 h^2} = -\frac{13.6 \text{ eV}}{n^2}$$

$h = 6.626 \times 10^{-34}$ J s $\qquad$ 1 eV = 1.6×10^{-19} J

$$E = h f = \frac{h c}{\lambda}$$

$c = 3.00 \times 10^{8}$ m/s $\qquad$ $c = f\,\lambda$