**Fall 2017 Exam 2 (Brotherton)**

**Phys 1210 (Ch. 5-8) \_\_\_\_\_\_\_\_\_\_**

 **your name**

The exam consists of 6 problems. Each problem is of equal value.

You can skip one of the problems (best five will count if you do all problems). Calculators are allowed.

Tips for better exam grades:

 Read all problems right away and ask questions as early as possible.

 Make sure that you give at least a basic relevant equation or figure for each problem.

You are encouraged to make use of the entire exam time. When you are done with solving the problems and there is some time left, read your answers over again and search for incomplete or wrong parts.

Show your work for full credit. The answer ‘42’ only earns you any credit IF ‘42’ is the right answer. We give points for ‘steps in between’, figures, units, etc.

 No credit given for illegible handwriting or flawed logic in an argument.

 Remember to give units on final answers.

 Please box final answers so we don’t miss them during grading.

 Please use blank paper to write answers, starting each problem on a new page.

**Please use 10 m/s2 as the acceleration due to gravity on Earth**. In general give your answers to two significant figures anyway.

 ‘Nuff said.

1. **The Batmobile Speeds around a turn.**

How fast can the Batmobile take a curve before sliding toward the outside of the curve? The semi-circular curve has a radius of curvature of 100 meters. Assume the coefficient of static friction is 0.90 and the Batmobile has a mass of 2000 kg. You should likely start the problem by drawing a free-body diagram (as for many of the problems here).

1. **A Slippery Situation**

A surprise ninja attack results in Black Widow (60 kg) being knocked onto a slanted roof (30 degrees from the horizontal). The coefficient of kinetic friction between her costume and the roof is 0.25. If she sides 10 m, starting from rest, how fast is she going?

1. **Wonder Woman pushes a tank out of a ditch.**

Wonder Woman pushes a tank (5000 kg) with broken treads up a 30 degree incline at a constant velocity of 1 m/s. If she pushes with 60,000 Newtons of force parallel to the incline, what is the constant of kinetic friction between the tank and the ground?

1. **The Terrible Tinkerer’s Trap**

Spider-man (50 kg) sneaks into the Tinkerer’s warehouse, but unfortunately steps on an area of floor featuring a trap. A super spring launches Spidey into the air! If the compressed spring expands 0.50 meters to equilibrium, and the spring constant is 40,000 N/m, how high will he go?

1. **Another Fastball Special.**

The X-men are fighting Sentinels (again) and Colossus throws Wolverine (80 kg) at a speed of 30 m/s toward one of the giant robots. The throw is a good one, and Wolverine hits the robot in its face, 5 meters above the ground. What is Wolverine’s speed when he hits? (As usual, use g=10 m/s2 downward and answer to 2 significant figures and ignore air resistance.)

1. **The Flash grabs Captain Cold.**

Captain Cold is skating on a large patch of ice that he has created to help him escape from a bank robbery. He has a mass of 80.0 kg, is skating at 10.0 m/s, and the ice can be considered frictionless for this problem. The Flash, 70 kg, sees the ice and tries to slow down and stop but slips on it instead. If he is coming up directly behind Captain Cold at 50.0 m/s, moving in the same direction, what is the speed of the pair after the Flash grabs him?

**Master Equations – Physics 1210**

One-dimensional motion with constant acceleration:

  find the other forms of master equation 1 by

1. building the derivative of the equation
2. solving the new equation for t and substituting it back into the master equation, and
3. using the equation for average velocity times time

Two-dimensional motion for an object with initial velocity vo at an angle relative to the horizontal, with constant acceleration in the y direction:



find the related velocities by building the derivatives of the equations

Newton’s Laws

find the related component equations by replacing all relevant properties by their component values

The quadratic equation and its solution:

Table with some values for trig functions:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Degrees: | 30 | 45 | 60 | 330 |  |
| sin | 0.5 | 0.707 | 0.866 | -0.5 |  |
| cos | 0.866 | 0.707 | 0.5 | 0.866 |  |
| tan | 0.577 | 1 | 1.732 | -0.577 |  |

**Work and Power definitions:**

 **Work**

 **Power P = dW/dt**

**Friction:**

 **F = - μk \* n (kinetic)**

 **F < - μs \* n (static upper limit)**

**Hook’s Law:**

 **F = kx (where k is the spring constant)**

**Kinetic Energy**:

 **K = ½ mv2 (linear)**

 **K = ½ I w2 (rotational)**

**Potential Energy**:

 **U = mgh (gravitational)**

 **U = ½ kx2 (elastic for a spring constant k)**

**Work-energy with both kinetic and potential energy:**

 **K1 + U1 + Wother = K2 + U2**

**Linear Momentum**:

**Impulse and Impulse-Momentum Theorem:**

**Angular-Linear Relationships**:

 **a = v2/r (uniform circular motion)**

 ***v = rω, atan = rα, and arad = v2/r = rω2***

**Parallel axis theorem for the moment of inertia I**:

 **Ip = Icm + Md2**

**Angular dynamics**:

 **Torque and**

**Angular Momentum:**

**Gravity:**

 **F = Gm1m2/r2**

 **U = -GmEm/r**

 **T (orbital period) = 2 π r 3/2/sqrt(GmE)**

 **G = 6.67x10-11 N·(m/kg)2**

**Periodic Motion**

 **f = 1/T; T= 1/f**

 **ω = 2π f = 2π/T (angular frequency here)**

 **ω = sqrt(k/m) (k is spring constant)**

 **x = A cos(ωt + Φ)**

 **ω = sqrt (κ/I) (angular harmonic motion)**

 **ω = sqrt (g/L) (simple pendulum)**

 **ω= sqrt (mgd/I) (physical pendulum)**

**Mechanical Waves in General**

 **V = λf**

 **Y(x,t) = A cos (kx- ωt) (k is wavenumber, k = 2 πf)**

 **V = sqrt (F/μ)**

 **Pav = ½ sqrt(μF) ω2 A2**

 **I1/I2 = (r2/r1)2 (inverse square law for intensity)**

**Sound Waves**

 **Pmax = BkA (B is bulk modulus)**

 **Β = (10 dB) log(I/I0) where I0 = 1x10-12 W/m2**

 **fL = fs \* (v+vL)/(v+vs) -- Doppler effect**



