**Practice Exam Spring 2017 (Brotherton)**

**Phys 1210 (Ch. 6-8) \_\_\_\_\_\_\_\_\_\_**

 **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 sub- problem.

 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 reserve 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.

 ‘Nuff said.

1. **Bullseye and Daredevil.** Bullseye is attacking Daredevil and throws a baseball (145 g) at 40 m/s at his head. Daredevil throws his club (0.5 kg) at 20 m/s back, hitting the ball just off center. If the club continues forward but is deflected up at an angle of 20 degrees, and slows to 15 m/s, what is the new trajectory of the baseball? What is its angle of deflection down and new speed just after the collision?
2. **Any icy slide ride.** Iceman has made a crazy slide ride with a loop. If the slide starts at a height of 50 meters, goes downhill, and then loops at the bottom, with a radius of 5 meters, what is the magnitude and direction of the acceleration at the top of the loop? Assume the ice slide is frictionless.
3. **Spider-man swings on his webline.**

Spider-man is standing at the top of a building 150 meters high. He shoots his web toward a flag pole 20 meters lower than his height on the side of another building. He steps off the building and uses the taught webline to swing away. If the webline is 50 meters long, how fast is he moving in m/s at the bottom of his swing? Ignore air resistance and friction, and use g =10 m/s2.

1. **Batman Saves Batgirl and Robin**

Following the explosion of a bobby-trapped Jack-in-the-Box left by the Joker, Batman (120 kg) is standing on top of a building holding onto a spring from which dangles Batgirl (60 kg). She in turn is holding another spring from which dangles Robin (50 kg). If the spring constant k = 5 N/mm for both springs, by what lengths are the two springs stretched? Again, use g = 10 m/s2 and provide your answer in meters.

1. **Black Widow’s guns.**

In the Avengers movie, the Black Widow uses a pair of Glock 26s. The mass of an unloaded Glock 26 is 615 grams (they’re small!). The mass of one type of 9mm bullet used in the Glock 26 is 7.5 grams. The velocity of this bullet shot from the Glock 26 is about 370 m/s. What is the recoil velocity of a Glock 26 firing its last bullet in m/s? What is the ratio of the kinetic energy in the bullet to that of the recoiling gun?

1. **Bouncing Boy Bounces off a wall.**

One of the less well known members of the Legion of Superheroes is Bouncing Boy, who can, well, bounce. Darkseid throws Bouncing Boy into a wall at 50 m/s, but Bouncing Boy bounces back, perfectly elastic, at 50 m/s to return to the fight! His mass is 100 kg. What is the impulse of the wall on Bouncing Boy? If he is in contact with the wall for 0.1 seconds, what is the average force exerted on him by the wall?

**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**

**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:**

**Fluid Mechanics**

 **p = p0 + ρgh (pressure in an incompressible fluid of constant density)**

 **A1v1 = A2v2 (continuity equation, incompressible fluid)**

 **dV/dt = Av**

 **p1 + ρgy1 + ½ ρv12 = p2 + ρgy2 + ½ ρv22 (steady flow, ideal fluid)**

**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**



