**Spring 2015 Practice Exam 2**

**Phys 1210 (Ch. 6-9) \_\_\_\_\_\_\_\_\_\_**

 **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. **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 (again)**

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. **Wonder Woman Deflects Bullets.**

Every superhero needs a way to deal with bullets. Wonder Woman uses her bracelets to deflect them. If a 5 gram bullet heads toward her at 300 m/s and is deflected so it is moving back in the direction it came from, 45 degrees from the horizontal at a speed of 200 m/s. What is the impulse of the net force? If the bullet is in contact with the bracelet for 0.0010 seconds, what is the average force applied to deflect it?

1. **Moment of Inertia of Thor’s Hammer.**

Thor’s hammer has a leather strap at the end that he often uses to swing the weapon around. Approximate the handle as a slender rod 0.32 m long with a mass of 5 kilograms. Approximate the head of the hammer as another slender rod with a mass of 15 kg and a length of 0.24 meters, with the handle attaching in the middle. Calculate the moment of inertia for rotation around the end of the handle, with the rotation axis perpendicular to the plane of the hammer on its side.

1. **Hit Girl Drops In.**

Hit Girl rides in a bucket down into a warehouse where there is criminal activity to destroy. She masses 40 kg. The bucket is connected by a rope to an unwinding spool (that can be treated as a solid cylinder) of mass 50 kg and a radius of 0.5 meters. Ignore the mass of the rope and the bucket. If the roof is 20 meters above the floor, how long does it take her?

**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:**

**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**



