Oberlin College Physics 103, Fall 2023

Sample Exam 2

Wednesday,1 November

There will be a 50-minute exam on Wednesday, 8 November, from 10:00 am to 10:50 am. I recommend that you write in your own words a one-page summary (use both sides) of the most important and most difficult-to-remember equations, principles, and ideas, and bring it to this exam. This is the only written material you may consult while taking the exam. Calculators are permitted, collaboration is not.

Exam topics are force and Newton's laws; work; kinetic and potential energy; impulse and momentum; collisions; centripetal acceleration; projectile motion.

Sample exam:

1. Two identical toy boats, each weighing 1.2 pounds, are at rest in the calm reflecting pool outside the Oberlin Conservatory of Music. A 0.32 pound chipmunk sleeps on one boat. The chipmunk wakes up and jumps from its boat to the other. The boat jumped from recoils at speed 52 cm/s. After the chipmunk lands on the second boat, what is its speed?
   (*Answer:* Use momentum conservation to find 42 cm/s. Two significant figures.)

2. A lead ball is pushed horizontally from a lab bench at speed v_0. If the bench top is distance h above the floor, how much time does it take to reach the floor?
   (*Answer:* The datum v_0 is irrelevant; the time required is $\sqrt{2h/g}$.)

3. Some years ago my wife Katie was involved in a traffic accident; fortunately, no one involved was seriously hurt. Katie was driving east on College Street in her small Toyota Corolla when a Buick Estate station wagon heading south on Prospect Street ran through a stop sign and smashed into the Corolla's rear door. (If the station wagon had run into the front door, Katie would have been seriously injured or killed.) The two cars stuck together and came to rest only when they knocked over the telephone pole at the southeast corner of the intersection. I knew that Katie, a scrupulous rule-follower, was driving down College Street at the speed limit of 25 miles per hour. I looked up the cars: a Toyota Corolla weighs about 3000 pounds; a Buick Estate station wagon weighs about 5000 pounds. About how fast was the station wagon going before the collision?
   (*Answer:* 15 miles per hour.)

4. On 11 July 1979 NASA's *Skylab* fell back to Earth. Its orbit had been at altitude 148 km and speed 7950 m/s. One of the largest fragments to strike the Earth's surface was a lead-lined film vault of mass 1770 kg; the impact crater suggested that it stuck at speed 123 m/s. How much nonconservative work was done on the film vault during its reentry?
   (*Answer:* 5.85×10^{10} J. Three significant figures.)