Schedule – Reading and Home-fun

week	topic	Reading Morin	Reading Brown	HF Morin	HF Brown	HF Reynolds	Due date
6	energy	Ch 5	3.1, 3.2	All MC, P 5.2, 5.3, 5.5, 5.8, 5.21	W3: 2, 3, 4	1-8	Wed 2/24
7	energy, work, momentum	Ch 5-6	3.3-3.6, 4.2-4.5	P 5.11(a), 6.3, 6.6, 6.12	W3: 5,7,8 W4: 5, 6	9-14	Wed 3/2
8	momentum	Ch 6	4.6-4.9				Wed 3/9
9	Review/probs				**Test #2**		**Fri 3/11**

HF = Home-fun
MC = Multiple choice (not to be turned in)
P = problems
W = week

Reynolds Problems

Work

1. A factory worker pushes a 30.0-kg crate a distance of 4.5 m along a level floor at constant velocity by pushing horizontally on it. The coefficient of kinetic friction between the crate and the floor is 0.25. (a) What magnitude of force must the worker apply? (b)How much work is done on the crate by this force? (c) How much work is done on the crate by friction? (d) How much work is done on the crate by the normal force? By gravity? (e) What is the total work done on the crate?

   answers: (a) 74 N (b) 330 J (c) -330 J (d) 0, 0 (e) 0

2. Suppose the worker in the previous problem pushes downward at an angle of 30 degrees below the horizontal. (a) What magnitude of force must the worker apply to move the crate at constant velocity? (b) How much work is done on the crate by this force when the crate is pushed a distance of 4.5 m? (c) How much work is done on the crate by friction during this displacement? (d) How much work is done on the crate by the normal force? By gravity? (e) What is the total work done on the crate?

Kinetic Energy

3. Some typical kinetic energies: (a) How many joules of kinetic energy does a 75-kg person have when walking and when running? (c) If you drop a 1.0-kg weight (about 2 lb) from shoulder height, how many joules of kinetic energy will it have when it reaches the ground? (d) Is it reasonable that a 30-kg child could run fast enough to have 100 J of kinetic energy?

4. (a) In the Bohr model of the atom, the ground-state electron in hydrogen has an orbital speed of 2190 km/s. What is its kinetic energy? (b) The mass of a proton is 1836 times the mass of an electron. (a) A proton is traveling at speed v. At what speed (in terms of v) would an electron have the same kinetic energy as the proton? (c)An electron has kinetic energy K. If a proton has the same speed as the electron, what is its kinetic energy (in terms of K)?

5. Meteor Crater: About 50,000 years ago, a meteor crashed into the earth near present-day Flagstaff, Arizona. Recent (2005) measurements estimate that this meteor had a mass of about 1.4×10^8 kg (around 150,000 tons) and hit the ground at 12 km/s. (a) How much kinetic energy did this meteor deliver to the ground? (b) How does this energy compare to the energy released by a 1.0-megaton nuclear bomb? (A megaton bomb releases the same energy as a million tons of TNT, and 1.0 ton of TNT releases 4.184×10^9 J of energy.)

Work-Energy Theorem

6. A car is traveling on a level road with speed v_0 at the instant when the brakes lock, so that the tires slide rather than roll. (a) Use the work-energy theorem to calculate the minimum stopping distance of the car in terms of v_0, g, and the coefficient of kinetic friction μ_k between the tires and the road. (b) By what factor would the minimum stopping distance change if (i) the coefficient of kinetic friction were doubled, or (ii) the initial speed were doubled, or (iii) both the coefficient of kinetic friction and the initial speed were doubled?

Potential Energy

7. A small rock with mass 0.12 kg is fastened to a massless string with length 0.80 m to form a pendulum. The pendulum is swinging so as to make a maximum angle of 45 degrees with the vertical. Air resistance is negligible. (a) What is the speed of the rock when the string passes through the vertical position? (b) What is the tension in the string as it passes through the vertical?

8. A force of 800 N stretches a certain spring a distance of 0.200 m. (a) What is the potential energy of the spring when it is stretched 0.200 m? (b) What is its potential energy when it is compressed 5.00 cm?

Reynolds Problems

9. Consider a spring with spring constant k and an equilibrium length ℓ_0. Orient the spring vertically and suspend a mass m from one end. What is the new, stretched, length of the spring? If you pull the mass down a small distance, Δx, from this new equilibrium position, what is the restoring force on m?

Some train problems

10. A bullet train (m =20,000 kg), moving at 300 km/hour, is arriving at the station. One kilometer from the end of the track the engineer realizes that he's traveling too fast and slams on his brakes so that the train starts sliding along the track.

    (a) Just before the braking begins, what is the kinetic energy of the train? (b) Assuming that the coefficient of kinetic friction between the train's wheels and the track is $\mu_k =$ 0.3, how much work is done *by* the friction force *on* the train over that one kilometer? (c) This work does not dissipate all of the kinetic energy of the train. Luckily, there is a large spring at the end of the track with a large spring constant $k = 10^6$ N/m. How far does the train compress this spring before finally coming to rest?

11. You are standing on a subway platform watching your train pull away from the station. The first car takes 1.5 s to pass you, and the second car passes you in 1.1 s. If each car is 8.6 m long, what is the (constant) acceleration of the train?

12. Two trains, each having a speed of 30 km/hr, are headed at each other on the same straight track. A bird that can fly 60 km/hr flies off the front of one train when they are 60 km apart and heads directly for the other train. On reaching the other train it flies directly back to the first train, and so forth. What is the total distance the bird travels before it is crushed by the two trains as they meet?

    Solve this both the easy way and the hard way.

Impulse

13. Calculate the magnitude of the momentum of (a) Usain Bolt (94 kg) as he breaks the world record by running 100 m in 9.58 s, (b) a standard MLB baseball as it's thrown by Aroldis Chapman at a world record 105.1 mph.

14. An engine of the OMS (orbital maneuvering system) on the space shuttle exerts a force of 26,700 N for 3.9 s. (a) What is the magnitude of the impulse that is delivered to the shuttle? (b) What is the magnitude of the shuttle's change in momentum due to this impulse? (c) What is the magnitude shuttle's change in velocity due to this impulse? (d) Why can't we calculate the resulting change in the kinetic energy of the shuttle?