

## Physics 1145 Homework for week 11: Springs. Linear Momentum and Impulse

1. You are using a spring scale with a force constant of 500 N/m and initial length of 20 cm to weigh a turkey. The spring stretches to 30 cm. Calculate the mass of the turkey.

2. A spring is hanging vertically. You hang a mass of 300 g on the lower end of the spring and the spring stretches 5.0 cm from its equilibrium position

a) Calculate the spring constant of this spring.

b) If you hang an additional 100 g on the spring, how much further does it stretch?

3. A baseball of mass 0.145kg is moving at 40m/s in the negative  $x$ -direction. After being hit by the bat, it moves with speed 50m/s at an angle  $30^\circ$  above the positive  $x$ -axis. The ball is in contact with the bat for 2 ms.

Calculate the  $x$ - and  $y$ -components of the impulse delivered to the ball by the bat and the  $x$ - and  $y$ -components of the average force exerted on the ball by the bat.

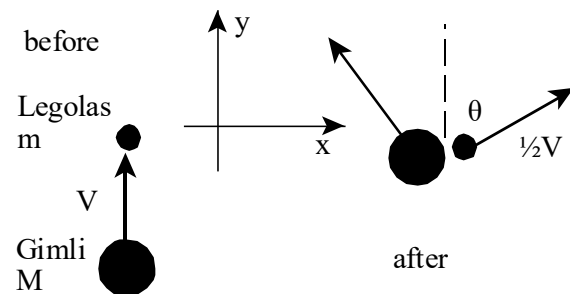
4. Squid move by jet propulsion. A 1.1 kg squid at rest suddenly expels 0.1kg of water with a speed of 20 m/s. What is the speed with which the squid moves in the opposite direction? (Ignore any other forces, such as drag forces.)

5. Gimli and Legolas are on a frozen pond. The pond surface is frictionless and horizontal. Legolas of mass  $m$  is originally standing still, gazing into the distance to look out for Orcs. Gimli with mass  $M$  is originally moving in the positive  $y$ -direction with speed  $V$ . He collides with Legolas.

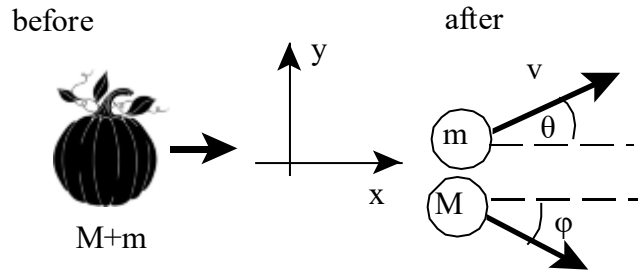
After the collision Legolas is moving with speed  $\frac{1}{2}V$  at angle  $\theta$  from the positive  $y$ -direction, while Gimli is moving at an unknown speed in some unknown direction.

Derive an expression for the  $x$ - and  $y$ -components of Gimli's velocity after the collision, in terms of system parameters.

Find Gimli's speed after the collision.



6. Students are testing their physics understanding by filling a pumpkin with an explosive material. The pumpkin of total mass  $M+m$  moves on a frictionless horizontal table in a straight line in the positive  $x$ -direction. It explodes and breaks up into two fragments of mass  $M$  and  $m$ , respectively. The figure shows a top view of the table. Immediately after the explosion, the fragment of mass  $m$  moves with speed  $v$  at an angle  $\theta$  above the positive  $x$ -direction; the fragment of mass  $M$  moves at an angle  $\phi$  below the positive  $x$ -direction. Startled by the explosion, the students failed to record the initial speed of the pumpkin and the final speed of the fragment of mass  $M$ . Derive an expression for the speed of the pumpkin before the explosion.



7. An UFO of mass  $5M$  and zero speed is in deep space. Due to a communication problem between the alien crew members from different planets, the UFO explodes into three fragments when they are trying to start the engines. One fragment of mass  $M$  moves in the positive  $x$ -direction with speed  $\frac{1}{2}V$ . The second fragment of mass  $2M$  moves with speed  $V$  at an angle  $\theta$  left of the positive  $y$ -axis. The third fragment has mass  $2M$ .

Find the  $x$ - and  $y$ -components of the velocity of fragment 3.

