T-1 Review Power and COp Per ____ Name Key

1. Homer Simpson while working at the Springfield Nuclear Power Plant uses a winch to lift a replacement fuel rod (mass = 27 kg). How long will it take Homer to lift the fuel rod 12 meters if the winch is rated at 750 W of power?

$m = 27\,kg$
$t = ?$
$h = 12\,m$
$P = 750\,W$

$$P = \frac{W}{t} = \frac{F \cdot d}{t} = \frac{F_g \cdot h}{t} = \frac{m \cdot g \cdot h}{t}$$

$$750\,W = \frac{(27\,kg)(9.8\,m/s^2)(12\,m)}{t}$$

$t = \boxed{4.23\ s}$

2. Bart pulls Lisa (m = 14 kg) around the parking lot of Springfield Elementary where the coefficient of kinetic friction between Lisa and the surface of the level parking lot is 0.5. How much power must be generated to move Lisa with a constant velocity of 7 m/s?

$m = 14\,kg$
$\mu = 0.5$
$P = ?$
$a = 0\,m/s^2$

$$F_f = F_N \cdot \mu = m \cdot g \cdot \mu = (14\,kg)(9.8\,m/s^2)(0.5) = 68.6\,N$$

$$P = \frac{F \cdot d}{t} = F_f \cdot v = (68.6\,N)(7\,m/s) \longrightarrow \boxed{480.2\,W}$$

3. When Bart swims in the Sea at full speed he is able to generate 7 **horsepower**. If Bart can swim at 2.5 m/s, how much total force do his arms and legs provide?

$P = 7\,hp = 5222\,W$
$v = 2.5\,m/s$
$F = ?$

$$P = F \cdot v$$
$$5222 = F \cdot (2.5)$$
$$F = \frac{5222\,W}{2.5\,m/s} \longrightarrow = \boxed{2088.8\,N}$$

4. A 1000 kg car moving **east** at 80 **km/hr** collides head on with a 1500 kg car moving **west** at 40 **km / hr**. If the two cars stick together after the collision, what is their speed **and direction**?

22.2 m/s

11.1 m/s

1000 kg, 22.2 m/s   1500, 11.1 m/s   1000 1500, $v_f = ?$

$$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f$$

$$\frac{(1000\,kg)(22.2\,m/s) + (1500\,kg)(-11.1\,m/s)}{(1000 + 1500)} = \frac{\cancel{(1000+1500)}\, v_f}{\cancel{(1000+1500)}}$$

speed = $\boxed{2.22\,m/s}$

direction = $\boxed{\text{east}}$

5. An over-ripe watermelon spontaneously explodes into two pieces. One piece with a mass of 2.5 kg is shot **east** at 22 m/s. The second piece with a mass of 1.6 kg moves to the **west.** What is the velocity of the second piece of watermelon?

$(1.6 + 2.5) \rightarrow$ 4.1 kg, $v_i = 0$ 1.6 kg, __ m/s   2.5 kg, 22 m/s

$$(m_1 + m_2) v_i = m_1 v_{1f} + m_2 v_{2f}$$

$$0 = (1.6)(-v_{1f}) + (2.5)(22)$$

$$\frac{\cancel{(1.6)}(v_{1f})}{\cancel{1.6}} = \frac{(2.5)(22)}{1.6}$$

$v = \boxed{34.38\,m/s}$ west

6. Bart Simpson (mass = 23 kg) was traveling at 12 m/s on his skateboard when he hit the wall of Springfield Elementary. If it took 0.002 seconds to come to a complete stop, how much force did the wall provide?

$m = 23\,kg$
$v_i = 12\,m/s$
$v_f = 0\,m/s$
$t = 0.002\,s$
$F = ?$

$$F = m \cdot a = m\frac{v_f - v_i}{t}$$

$$= \frac{(23)(0-12)}{0.002}$$

$\boxed{138{,}000\,N}$

7. A 0.0025 kg Junior Mint falling **downward** at 4 m/s bounces off of the operating room floor. If the mint was in contact with the floor for 0.003 seconds and the floor provided a force of 6.3 N, how fast will the mint bounce upward off of the floor?

$v_i = -4\,m/s$
$v_f = ?$
$F = 6.3\,N$
$t = 0.003\,s$
$m = 0.0025\,kg$

$$F = \frac{m(v_f - v_i)}{t}$$

$$6.3 = \frac{(0.0025)(v_f + 4)}{0.003}$$

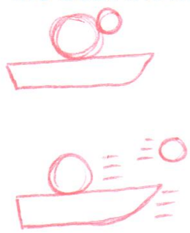
$$0.0189 = (0.0025)(v_f + 4)$$

$$v_f + 4 = \frac{0.0189}{0.0025}$$

$$v_f + 4 = 7.56$$

$v_f = \rightarrow \boxed{3.56\,m/s}$

8. Homer (mass = 75 kg) horizontally throws a life preserver (mass = 3 kg) to Marge from the 400 kg boat that he is in. If, after the throw, the life preserver is traveling at 4 m/s and the boat (with Homer in it) is traveling at 1 m/s in the **opposite direction** from the life preserver, how fast was the boat moving originally?



$$(m_1 + m_3 + m_2)v_i = (m_1 + m_2)v_{1,2f} + m_3 v_{3f}$$

$$(75 + 3 + 400)v_i = (75 + 400)(-1) + (3)(4)$$

$$\frac{\cancel{478}(v_i)}{\cancel{478}} = \frac{-475 + 12}{478}$$

$v_i = \boxed{-0.969\,m/s}$

9. It is well known that bullets fired at Superman (100 kg) simply BOUNCE off of his chest. Suppose a gangster sprays Superman's chest with one hundred bullets, each having a mass of 0.005 kg. Each bullet is traveling at 600 m/s when it strikes the man-of-steel's chest, and they **rebound straight back in the opposite direction** at 600 m/s. If Superman was initially hovering motionless in the air, how fast will he be moving after being fired upon?

$M = 100(0.005) = 0.5\,kg$
$v_i = 600\,m/s$
$v_f = -600\,m/s$

100 kg, 0.5 kg
$v = 0$, $v = 600\,m/s$
$p = 0$, $p = -300$

100 kg, 0.5 kg
$v = ?$, $v = 600\,m/s$

velocity is negative w/ orientation pictured. could be positive if set up diff.

$$\cancel{(100)(0)} + (0.5)(-600) = (100)(v) + (0.5)(600)$$

$$-300 = 100v + 300$$
$$-300 \qquad -300$$

$$\frac{-600}{100} = \frac{\cancel{100}v}{\cancel{100}}$$

$v = \boxed{-6\,m/s}$

10. A red bumper car (carrying Maggie) at an amusement park ride is traveling with a velocity of 0.7 m/s when it collides with a blue bumper car (carrying Itchy) of the same mass that was originally at rest. The blue car moves away with a velocity of 0.2 m/s. What is the velocity of the red car after the collision?

m, m | m, m
0.7 m/s, 0 m/s | 0.2 m/s, v = ?

$$(0.7)\cancel{m} + \cancel{(0)m} = (0.2)\cancel{m} + (v)\cancel{m}$$

$$0.7 = 0.2 + v \qquad v = 0.5\,m/s$$

$v = \boxed{0.5\,m/s}$