Name:_____ Date:_____ Class:_____

Physics 121 Impulse Practice

$$p = mv \qquad J = \Delta p \qquad J = Ft$$

1. Jerome plays middle linebacker for South's varsity football team. In a game against cross-town rival North, he delivered a hit to North's 82-kg running back, changing his eastward velocity of 5.6 m/s into a westward velocity of 2.5 m/s. What impulse does Jerome deliver to the running back? ***660 kg m/s west***
2. Kara was applying her makeup when she drove into South's busy parking lot last Friday morning. Unaware that Lisa was stopped in her lane 10 m ahead, Kara rear-ended Lisa's rented Taurus. Kara's 1300-kg car was moving at 11 m/s and stopped in 0.14 s.
    a. What impulse did Kara's car experience as she stopped? ***-1.4×10^4 kg m/s***
    b. What force was exerted on the car as she stopped? ***-1.0×10^5 N***
3. While playing basketball in PE class, Logan lost his balance after making a lay-up and colliding with the padded wall behind the basket. His 74-kg body decelerated from 7.6 m/s to 0 m/s in 0.16 s. What force did he experience from the wall? ***3.5×10^3 N***
4. If, using the same information from question 3, Logan instead hit a concrete wall and stopped in 0.008 s, what force would he feel in stopping? ***7.0×10^4 N***
5. NASA's Langley Research Center has been experimenting with the use of air bags to soften the landings of crew exploration vehicles on land. What stopping time will be required in order to safely stop a 7250 kg vehicle moving at 7.65 m/s with an average force of 426000 N? ***0.13 s***
6. In a study conducted by a University of Illinois researcher, the football team at Unity High School in Tolono, IL was equipped for an entire season with helmets containing accelerometers. Information about every impact in practice and in games was sent to a computer present on the sidelines. The study found that the average force on a top of the head impact was 1770 N and endured for 7.78 milliseconds. Using a head mass of 5.20 kg and presuming the head to be a *free body*, determine the velocity change experienced in such an impact. ***2.65 m/s***
7. Aaron Agin nodded off while driving home from play practice this past Sunday evening. His 1500-kg car hit a series of guardrails while moving at 19.8 m/s. The first guard rail delivered a resistive impulse of 5700 N•s. The second guard rail pushed against his car with a force of 79000 N for 0.12 seconds. The third guard rail collision lowered the car's velocity by 3.2 m/s. Determine the final velocity of the car. ***6.5 m/s***
8. Cassie has just finished her session on the trampoline during PE. As she prepares to exit the trampoline, her vertical momentum is reduced by a series of three resistive impulses with the bounce mat. Just prior to this series of impulses, her 48.5-kg body is moving downward at 8.20 m/s. On the first impulse, Cassie experiences an average upward force of 230 N for 0.65 seconds. The second impulse of 112 N•s lasts for 0.41 seconds. The last impulse involves an average upward force of 116 N which causes an 84 kg•m/s momentum change. What vertical velocity does Cassie have after these three impulses? ***1.08 m/s***
9. A 22 gram bullet is fired horizontally from a vertical height of 1.8 meters. If the bullet travels 242 meters horizontally as it lands, what impulse does the gun exert on the bullet? ***8.8 kg m/s***

Impulse Practice

① $J = m\Delta v$

$J = (82\ kg)(2.5\ m/s - (-5.6\ m/s))$

$J = 664.2\ kg \cdot m/s$

② a) $J = m\Delta v$

$J = (1300\ kg)(0 - 11\ m/s)$

$J = -14300\ kg \cdot m/s$

b) $J = Ft$

$-14300\ kg \cdot m/s = F(.14\ s)$

$F = -102,140\ N$

③ $J = m\Delta v = Ft$

$(74\ kg)(0 - 7.6\ m/s) = F(.16\ s)$

$F = -3515\ N$

④ $J = m\Delta v = Ft$

$(74\ kg)(0 - 7.6\ m/s) = F(.008\ s)$

$F = -70300\ N$

⑤ $J = m\Delta v = Ft$

$(7250\ kg)(0 - 7.65\ m/s) = (426000\ N)t$

$t = 0.13\ s$

⑥ $J = m\Delta v = Ft$

$(5.20\ kg)\Delta v = (1770\ N)(.00778\ s)$

$\Delta v = 2.65\ m/s$

⑦ $p_0 = mv_0 = 29700\ kg \cdot m/s$

$J_1 = -5700\ N \cdot s$

$p_1 = 24000\ kg \cdot m/s$

$J_2 = -Ft = -9480\ N \cdot s$

$p_2 = 14520\ kg \cdot m/s$

$J_3 = -m\Delta v = -4800\ kg \cdot m/s$

$p_f = 9720\ kg \cdot m/s = (1500\ kg)v_f$

$v_f = 6.48\ m/s$

⑨ $m = .022\ kg$

$J = m\Delta v$

$J = m(v_f - 0)$

$J = (.022\ kg)(396.7\ m/s)$

$J = 8.73\ kg \cdot m/s$

X	Y
$\Delta x = 242\ m$	$\Delta y = 1.9\ m$
$t = ?$	$v_{y_i} = 0$
$v_x = \frac{\Delta x}{t}$	$a = g$
$v_x = 396.7\ m/s$	$t = ?$

$\Delta y = v_i t + \frac{1}{2} a t^2$

$1.8\ m = \frac{1}{2} g t^2$

$t = 0.61\ s$

⑨ $p_0 = mv_0 = 397.7\ kg \cdot m/s$

$J_1 = Ft = -149.5\ N \cdot s$

$p_1 = 248.2\ kg \cdot m/s$

$J_2 = -112\ N \cdot s$

$p_2 = 136.2\ kg \cdot m/s$

$J_3 = -84\ kg \cdot m/s$

$p_f = 52.2\ kg \cdot m/s = (48.5\ kg)v_f$

$v_f = 1.08\ m/s$