AP Physics 1 Momentum Homework Answer Key

1. A bullet can have as much momentum as a truck if the bullet is moving fast enough and/or the truck is moving slow enough.
2. a. 30.0 N s, 180°
   b. 25.0 kg m/s, 180°
3. a. 0.475 kg m/s, 90.0°
   b. 0.475 N s, 90.0°
   c. 48.0 N, 270.0°
4. a. 250 N
   b. 0.333 m/s
5. a. 1.67 MN
   b. 3480 kg/s
6. a. 3600 N
   b. 47 m/s
7. The external force of friction acting on the tires is force that actually stops the car.
8. a. The kid moving forward in the wagon does not change the center of mass at all if there are no external forces, this means that the wagon must move backward at the same time the kid is moving forward.
   b. In reality, as the wagon moves back there is some amount of friction forward on the system. This forward force can cause the center of mass and the entire system to accelerate forward. Even though the opposite can happen when the kid rocks backward there can be a net forward result if the two actions are not equal in magnitude.
9. a. The center of mass is 0.35 m in front of the person and 0.95 m behind the center of the canoe.
   b. 0.218 m
   c. Assuming friction is negligible, there is no net external force on the two-object system. The person moving inside the canoe is an internal force and has no effect on the system as a whole. Therefore, the center of mass of the system must remain at rest relative to the Earth. The center of mass moves forward *relative to the canoe*, but the canoe must shift backward *relative to Earth* by an equal amount, such that the system "overall" has not moved.
10. a. The center of mass is unaffected by internal forces and therefore its velocity is unaltered by the collision, regardless of the severity of the interaction.
    b. The puck rebounding gives the box greater speed. If the puck sticks in the box the two objects will end up with the same velocity – that of the center of mass (which would move with the two objects). However, if the puck rebounds it will be getting farther and farther away from (and behind) the center of mass, which continues forward at the same speed. Therefore the box must move *faster* than the center of mass, also getting farther and farther away from (and ahead of) the center of mass.
11. a. 780 kg m/s, 0°
    b. 780 kg m/s, 180°
    c. 780 kg m/s, 0°
    d. 780 kg m/s, 180°
    e. 6.1 m/s

12. a. 160 g cm/s, 180°
    b. 16 cm/s, 180°
    c. 60 g cm/s
13. a. 4.8 m/s
    b. 6.5 to 3.2 kN
14. $v_0 = (n + 1)v$
15. 10.6 m/s
16. 5.0 m/s, west
17. a. $x_{cm} = -0.40$ m, $v_{cm} = +0.80$ m/s
    b. –0.40 m/s
    c. +5.5 m
18. 0.041 m/s forward,TD!
19. a. 3.20 kg
    b. If $d = 0.50$ m, then $t = 0.00125$ s, $F = 6400$ N, $Ft = 8.0$ Ns, which equals the change in momentum of the bullet as expected. If a shorter distance is chosen the time will be less, the force will be more, but the product will still be 8.0 Ns.
    c. Impulse of rifle on the person would not depend on the mass of the rifle. The momentum of the rifle recoiling should be equal and opposite to that of the bullet, regardless of the rifle's mass. The person holding the rifle must exert enough force for enough time to cause its momentum to change to zero. By the third law there is equal force and time back on the person and the combination would be 8.0 Ns regardless of the mass of the rifle.
20. 160 kg
21. a. angle would be 309°, not 325°
    b. 79 mph
    c. 26 mph (Q is lying)
22. a. No – energy is always conserved! Any kinetic energy lost will be converted to heat and sound.
    b. No – momentum is always conserved! Friction transfers momentum to the Earth.
23. a. 8.0 m/s
    b. 4.0×10^6 kg m/s
    c. 16 MJ; 8.0 MJ
    d. Lost energy is transformed to heat and sound.
24. a. 73 m/s
    b. 3.3 Ns, 180.0°
25. a. 0.800 m/s, 0°
    b. Yes elastic, $K_{total} = 3.04$ J before and after
    c. 1.40 m/s
    d. 5.4 cm
26. 6.67×10^{-27} kg
27. a. 17.3 kg m/s, 30.0°; 10.0 kg m/s, 300.0°
    b. 3.46 m/s, 30.0°; 2.00 m/s, 300.0°
    c. 40.0 J before and after