Physics 12 Unit 4 – Momentum Worksheet #1

1-D Problems including Gov Problems

KEY

Solutions.

Name: _____ Date: _____

1. Find the momentum of a 1300 kg car travelling at 55 km/hr.

$55 \div 3.6 = 15.27$

$p = mv = 1300 \cdot 15.27$

$= 19,860 \text{ N·s}$

2. A 0.3 kg ball is travelling north at 12 m/s and is then struck by a bat, afterwards the ball is travelling at 21 m/s south.

a) Find the change in velocity (magnitude only)

let's call North (+) $v_i = 12$ $v_f = -21$

$\Delta v = v_f - v_i$

$= -21 - 12$

$\Delta v = -33 \text{ m/s}$

(-) just indicates south.

b) Find the change in momentum. *Also described as the impulse imparted on the ball.*

$\Delta p = m\Delta v = (0.3)(-33) = 9.9 \text{ N·s}$

c) If the collision lasts 0.21 second, what is the average force exerted on the ball during the collision.

$\Delta p = Ft = m\Delta v$ → solve for F

$F = \frac{m\Delta v}{t} = \frac{(.3)(-33)}{.21}$

$F = \frac{9.9}{.21} = 47.1 \text{ N}$

3. A 3 kg hammer strikes a nail at a velocity of 8.5 m/s and comes to rest in a time interval of 8 ms (0.008 sec). What is the average force acting on the nail.

$$F = \frac{m\Delta v}{\Delta t} = \frac{(3)(8.5)}{.008}$$

$\Delta v = v_f - v_i$
$= 0 - 8.5$
$= -8.5$

$F = 3188\,N$

4. A 1400 kg car travelling at ~~130 km/hr~~ hits a parked 1800 kg truck. Assuming the two vehicles become entangled, find the velocity of the wreck.

$= 36.111$ m/s

$p_i = p_f$

CAR + TRUCK = WRECK.

$mv + Mv = mV$

$(1400)(36.111) + (1800)(0) = 3200\,V$?

$V = 15.799$
$= 15.8$ m/s

5. A 1400 kg car travelling at 130 km/hr hits a 1800 kg truck travelling the same direction at 90 km/hr. Assuming the two vehicles become entangled, find the velocity of the wreck.

25 m/s

note: both same direction, so

$p_i = p_f$

$mv + Mv = mV$

$(1400)(36.111) + (1800)(25) = 3200\,V$?

$V = 29.861$ m/s

$V = 29.9$ m/s

6. A 1400 kg car travelling at 130 km/hr hits a 1800 kg truck travelling the same direction at 90 km/hr. After the collision the truck is travelling at 105 km/hr in the original direction, find the velocity of the car.

$= 29.16$

$p_i = p_f$

CAR TRUCK CAR TRUCK.

$mv + mv = mv + mv.$

$(1400)(36.111) + (1800)(25) = (1400)v + (1800)(29.16).$

$V_{CAR} = 30.753$

$= 30.8 \text{ m/s}$

7. A 12,600 kg railroad car travels alone on a level frictionless track with a constant speed of 18 m/s. A 5350 kg load, initially at rest, is dropped onto the car. What will be the car's new speed?

$p_i = p_f.$

$mv = mv.$

$(12,600)(18) = (17,950)v$

$v = 12.64$

$v = 12.6 \text{ m/s}$

8. Calculate the force exerted on a rocket given that the propelling gases are expelled at a rate of 1500 kg/sec with a speed of 40,000 m/s.

load @ one second

$\Delta p = F \Delta t = mv$

1

$?$

$F = \frac{mv}{t} = \frac{(1500)(40,000)}{1 \text{ sec}} = 60,000,000 \text{ N}$

OR

$6 \times 10^7 \text{ N}$

call west (+)

9. Use conservation of momentum.

A 5.0 kg ice block is sliding along a smooth floor at 1.0 m/s west when a 0.20 N force directed east acts on it for 4.0 s. What is the magnitude of the block's final momentum?

A. 0.80 kg m/s
B. 4.2 kg m/s
C. 5.0 kg m/s
D. 5.8 kg m/s

$-P$

$\Delta p = P_f - P_i$

$(F)(t) = P_f - mv_i$

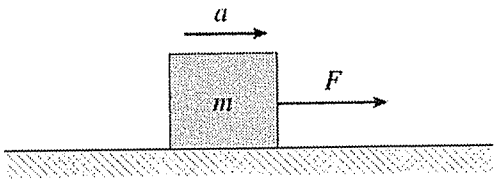
$(-.2)(4) = P_f - (5)(1)$

$-.8 = P_f - 5$

$4.2 = P_f$

10. Change of rate means per unit time, (change in p)/time

The force F shown below is pulling the mass m over a frictionless surface with an acceleration of a.



Which of the following is equal to the mass's rate of change of momentum?

A. F
B. $\frac{F}{a}$
C. $\frac{F}{m}$
D. $F \cdot a$

$\frac{\Delta p}{\Delta t} = \frac{m \Delta V}{t}$

$= m \cdot \frac{\Delta V}{t}$

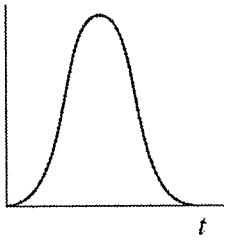
$= m \cdot a$

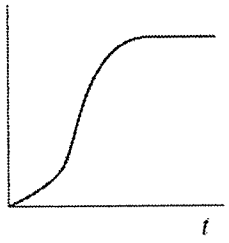
11. What property of the graph represents Δ p = Ft

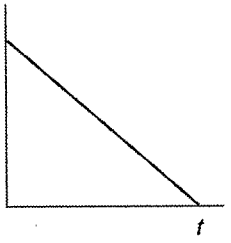
need $F_{\perp}$ graph so (A)

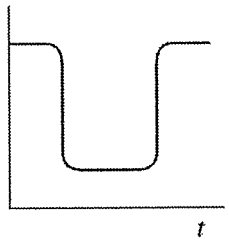
The area under which graph best represents the impulse delivered by a tennis racket to a ball?

only choice that makes sense.

(A.) 

B. 

C. 

D. 

12. Look at change in momentum for each cart.

CART 1 CART 2.

A 2.0 kg cart travelling east at 4.0 m/s strikes a stationary 8.0 kg cart. After the collision, the 2.0 kg cart bounces back towards the west at 2.0 m/s , while the 8.0 kg cart travels east at 1.5 m/s . Which of the following is the change in momentum for each cart?

	2.0 kg CART Δp (kg · m/s)	8.0 kg CART Δp (kg · m/s)
A.	4.0 East	12 West
B.	4.0 West	12 East
C.	12 East	12 West
(D.)	12 West	12 East

let's call east (+)

CART 1 $\Delta p = p_f - p_i = mv_f - mv_i = (2)(-2) - (2)(4) = -4 - 8 = -12$ (west)

CART 2 $\Delta p = p_f - p_i = mv_f - mv_i = (8)(1.5) - (8)(0) = 12$ (east)

13. Draw this problem out to clarify the physical situation.

A 7.3×10^3 kg space vehicle and its empty 6.8×10^2 kg booster unit are moving together through space at 370 m/s. An explosion lasting 2.2 s is used to separate the two parts. If the speed of the space vehicle after the separation is increased to 430 m/s, what impulse acted on the booster unit?

A. 4.1×10^4 N·s
B. 2.0×10^5 N·s
C. 2.2×10^5 N·s
D. 4.4×10^5 N·s

$p_i = p_f$

$mv = mv + mv$

$(7.3\times10^3)(370) = (7.3\times10^3)(430) + (6.8\times10^2)(v)$?

$7.3\times10^3 + 6.8\times10^2$

$(7300 + 680)(370) = (7.3\times10^3)(430) + (680)(v)$

V_f of booster $= -274$ m/s

$\Delta p_{\text{Booster}} = mv_f - mv_i = (680)(-274) - (680)(370)$

$= 437{,}900$ N·s.

OR $\Delta p_{\text{BOOSTER}} = \Delta p_{\text{space vehicle}} = mv_f - mv_i$

$= (7300)(430) - (7300)(370)$

$\Delta p_{\text{BOOSTER}} = 438{,}000$ N·s.

Same answer either way