use sig figs

F=ma

Newton's Second Law of Motion - Worksheet 3

1. A little boy pushes a wagon with his dog in it. The mass of the dog and wagon together is 45 kg. The wagon accelerates at 0.85 m/s^2. What force is the boy pulling with? 38N = F

2. A 1650 kg car accelerates at a rate of 4.0 m/s^2. How much force is the car's engine producing? 6.6×10^3 N = F

3. A 68 kg runner exerts a force of 59 N. What is the acceleration of the runner? 0.87 m/s^2 = a

4. A crate is dragged across an ice covered lake. The box accelerates at 0.08 m/s^2 and is pulled by a 47 N force. What is the mass of the box? 600 kg = m

5. 3 women push a stalled car. Each woman pushes with a 425 N force. What is the mass of the car if the car accelerates at 0.85 m/s^2? x3
m = 1.5×10^2 kg

6. A tennis ball, 0.314 kg, is accelerated at a rate of 164 m/s^2 when hit by a professional tennis player. What force does the player's tennis racket exert on the ball? 51.5N = F

7. In an airplane crash a woman is holding an 8.18 kg baby. In the crash the woman experiences a horizontal de-acceleration of 88.2 m/s^2. How many g's is this de-acceleration? How much force must the woman exert to hold the baby in place? → 9G; 9.8 m/s^2 = 1G
F = 721 N

8. When an F-14 airplane takes-off an aircraft carrier it is literally catapulted off the flight deck. The plane's final speed at take-off is 68.2 m/s. The F-14 starts from rest. The plane accelerates in 2 seconds and has a mass of 29,545 kg. What is the total force that gets the F-14 in the air? $F=(29545)\left(\frac{68.2-0}{2}\right) = 1{,}007{,}484.5 =$ (1 sf) 1×10^6 N

9. A sports car accelerates from 0 to 60 mph, 27 m/s, in 6.3 seconds. The car exerts a force of 4106 N. What is the mass of the car? $m = \frac{F}{a} = \frac{F}{\left(\frac{V_f - V_i}{t}\right)} = \frac{4106}{4.2857} = 960$ kg

10. A sled is pushed along an ice covered lake. It has some initial velocity before coming to a rest in 15 m. It took 23 seconds before the sled and rider come to a rest. If the rider and sled have a combined mass of 52.5 kg, what is the magnitude and direction of the stopping force? What do "we" call the stopping force? DON'T DO

11. A car is pulled with a force of 10,000 N. The car's mass is 1267 kg. But, the car covers 394.6 m in 15 seconds.
    (a) What is expected acceleration of the car from the 10,000 N force?
    (b) What is the actual acceleration of the car from the observed data of x and t?
    (c) What is the difference in accelerations?
    (d) What force caused this difference in acceleration?
    (e) What is the magnitude and direction of the force that caused the difference in acceleration?

    DON'T DO

12. A little car has a maximum acceleration of 2.57 m/s^2. What is the new maximum acceleration of the little car if it tows another car that has the same mass? 2.57/2 = 1.29 m/s^2

13. A boy can accelerate at 1.00 m/s^2 over a short distance. If the boy were to take an energy pill and suddenly have the ability to accelerate at 5.6 m/s^2, then how would his new energy-pill-force compare to his earlier force? If the boy's earlier force was 45 N, what is the size of his energy-pill-force?

45N = m1
45 = m

x = m5.6
= (45)(5.6) = 252N

Physics **Impulse Momentum Worksheet 1** **Name:** ______________________________ **Pd:** ______

Try the following three problems. For all problems round "g" from 9.8 m/s^2 to 10 m/s^2

1. A 10 N force is applied to a 10 kg mass for three seconds. The mass starts from rest.
   a. Determine the acceleration of the mass
   b. Determine the final velocity

a) $a = \frac{F}{m} = \frac{10N}{10kg} = 1\ m/s^2$

b) $a = \frac{V_f - V_i}{t}$ $V_f = at + V_i$ $= (1)(3) + 0 = 3\ m/s$

2. A 100 kg box initially traveling at 10 m/s encounters a frictional force and takes 5 seconds to slow down to a stop.
   a. Determine the acceleration of the box (direction matters + or -)
   b. If friction is the only unbalanced force, what is its value?

a) $a = \frac{V_f - V_i}{t} = \frac{0-10}{5} = -2\ m/s^2$

b) $F = (100)(-2) = -200N$

3. A 5 kg mass initially falling with a speed of 3 m/s is later falling with a speed of 23 m/s.
   a. How much time did this take for its speed to change?
   b. What was the amount of force acting on the mass?

a) $V_f = at + V_i$; $\frac{V_f - V_i}{a} = t = \frac{23-3}{10} = 2\ s$

b) $F = (5)(10) = 50N$

4. Complete the following table based on the three problems above.

	Net F (N)	t (s)	m (kg)	v_i (m/s)	v_f (m/s)	mv_i (kg·m/s)	mv_f (kg·m/s)	F·t (N·s)	Δmv (kg·m/s) final-initial
Problem 1	10N	3s	10kg	0 m/s	3 m/s	0 kgm/s	30 kgm/s	30Ns	30 kgm/s
Problem 2	-200N	5s	100kg	10 m/s	0 m/s	1000 kgm/s	0 kgm/s	-1000Ns	-1000 kgm/s
Problem 3	50N	2s	5kg	3 m/s	23 m/s	15 kgm/s	115 kgm/s	100Ns	100 kgm/s

5. What do you notice about the value and sign of the last two columns?

SAME because impulse (F·t) = Δmv change in momentum

6. Thinking about how the unit of Newton is defined (based on F=m·a) show how a NS is equivalent to kgm/s

$N = kg \cdot m/s^2$

$N \cdot s = \frac{kgm}{s^{\not 2}} \cdot \frac{\not s}{1} = kgm/s$

Δp

The quantity **F** · **t** is known as Impulse (J) and the quantity **m** · **v** is known as momentum (p). The symbol for Impulse is obviously "J" and the symbol for momentum is obviously "p". Isn't physics logical?! So impulse describes an amount of force taking into account the amount of time it's applied while momentum describes velocity taking into account its mass.

we will use Δp instead of J

So we have ourselves a new relationship. Just like Newton's Laws tell us that Forces cause accelerations we now have Impulses cause Momentum to change or the amount of Impulse is exactly equal to the amount the momentum changes by.

7. A 10 N force is applied to a 5 kg mass for 10 seconds. The mass starts from rest.
   a. What is the Impulse?
   b. What is the change in momentum?
   c. What is the initial momentum (starts from rest)
   d. Solve for the final momentum
   e. Determine the final velocity

a) $\Delta p = F \cdot t = (10)(10) = 100\ kgm/s$ ↑ same thing
b) $\Delta p = (m)(v_f - v_i) = 100\ kgm/s$
c) $p_i = (m)(v_i) = (5kg)(0\ m/s) = 0\ kgm/s$
d) $p_f = 5 \cdot 20 = 100\ kgm/s$
e) $\Delta p = m(v_f - 0)$ $\quad 100 kgm/s = (5kg)(x)$ $\quad v_f = 20 m/s$

8. A 100 kg box initially traveling at 10 m/s encounters a friction force of 10 N for 2 seconds. −10N
   a. What is the Impulse (be careful of direction!)?
   b. What is the change in momentum
   c. What is the initial momentum
   d. Solve for the final momentum
   e. Determine the final velocity

a) $\Delta p = (-10N)(2s) = -20\ kgm/s$
b) $\Delta p = -20\ kgm/s$
c) $p_i = mv_i = (100kg)(10m/s) = 1000\ kgm/s$
d) $\Delta p = p_f - p_i$ $\quad -20 = x - 1000$ $\quad p_f = 980\ kgm/s$
e) $p_f = mv_f$ $\quad v_f = \frac{p_f}{m} = \frac{980}{100} = 9.8\ m/s$

9. A 5 kg ball initially traveling at 10 m/s speeds up for 20 seconds to a speed of 60 m/s.
   a. What is the initial momentum?
   b. What is the final momentum?
   c. What is the change in momentum?
   d. What is the Impulse?
   e. How much force was applied?

a) $p_i = mv_i = (5)(10) = 50\ kgm/s$
b) $p_f = mv_f = (50)(60) = 3000\ kgm/s$
c) $\Delta p = p_f - p_i = 3000 - 50 = 2950\ kgm/s$
d) $\Delta p = 2950\ kgm/s$
e) $\Delta p = F \cdot t$ $\quad F = \frac{\Delta p}{t} = \frac{2950}{20} = 147.5N$

Name: ____________________________ Form: ______

Worksheet 3 - Impulse

Exercise 1: Use **impulse = F x t** to solve the following problems.

a) A football player kicks a ball with a force of 50N. Find the impulse on the ball if his foot stays in contact with the football for 0.01s.

$\Delta p = 0.5 \, kgm/s$

b) A hockey player applies an average force of 80N to a 0.25kg hockey puck for a time of 0.2s. Determine the impulse experienced by the hockey puck.

$\Delta p = 16 \, kgm/s$

c) Aunt Mary needs to hang a picture in her bedroom. She uses a hammer to drive the nail into the wall. Find the force exerted by the hammer on the nail if the hammer stays in contact with the nail for 0.5s and has an impulse of 25Ns.

$F = \frac{\Delta p}{t} = 50N$

Exercise 2: Use **impulse = change in momentum** to solve the following:

a) A 0.5kg baseball experiences a 10N force for a duration of 0.1s. What is the change in velocity of the baseball?

$\Delta p = 1 \, kgm/s = m\Delta v \quad \Delta v = \frac{1}{0.5} = 2 \, m/s$

b) A space shuttle burns fuel at the rate of 13,000kg in each second. Find the force exerted by the fuel on the shuttle if in 2s the shuttle experiences a change in momentum of 325,000kgm/s.

$\Delta p = 325,000 \, kgm/s \quad F = 162500 \, N$

$t = 2s$

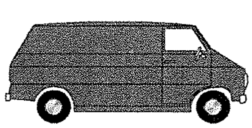
Exercise 3: A van of mass 1200kg was moving at a velocity of 8m/s when it was involved in a head on collision with a lorry moving in the opposite direction. Assuming that the van came to stop after the collision,

i. calculate the momentum of the van before the collision $p_i = (1200)(8) = 9600 \, kgm/s$

ii. work out the momentum of the van after the collision $p_f = 0 \, kgm/s$

iii. find the change in momentum of the van $\Delta p = -9600 \, kgm/s$

iv. if the van took 0.3s to stop, calculate the force that acted on each driver.



$F = -32000N$