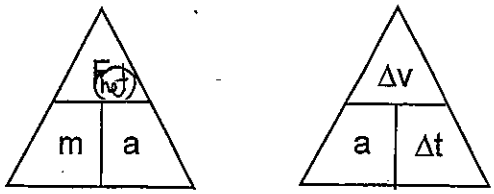
Name_____ Per. _____

Force, Mass, and Acceleration Practice Problems

Formulas: $F_{net} = ma$ (Force = mass x acceleration)

$a = \frac{\Delta v}{\Delta t}$ (acceleration = change in velocity divided by change in time)



Units: Force: Newtons (N)
acceleration : m/sec/sec or m/sec²
velocity: m/sec

Conversions: 1 kg = 1000 g
1 kg weighs ~ 10 N on Earth
1 N = 1 kg x m/sec²
acceleration due to gravity on earth ~ 10 m/sec/sec = 10 m/sec²

Problems:

1a. Car A accelerates at 2 m/sec². Car A has a mass of 750 kg. What is the Force on Car A?	1b. Car B has a mass of 1000 kg, and also accelerates at 2 m/s². What is the force on Car B?
Knowns: $A = 2\ m/s^2$, $M = 750\ kg$	Knowns: $A = 2\ m/s^2$, $M = 1000\ kg$
Unknown: F_{net}	Unknown: F_{net}
Equation: $F_{net} = M \cdot A$	Equation: $F_{net} = M \cdot A$
Fill in numbers: $= 750\ kg \cdot 2\ m/s^2$	Fill in numbers: $F_{net} = 1000\ kg \cdot 2\ m/s^2$
Answer with units: $= \boxed{1500\ N}$	Answer with units: $F_{net} = \boxed{2000\ N}$

1c. If you are concerned with the price of gas, which car would you rather drive and why?

Car A because it require less force to move. Overtime, this results in less gas being needed to put the car into motion

2a. A 500 kg rocket can accelerate from rest to a speed of 600 m/s in 2 sec. What is the acceleration of the rocket?

Knowns:

$\Delta V = 600$ m/s

$\Delta t = 2$ sec

Unknown:

a

Equation:

$a = \frac{\Delta V}{\Delta t}$

Fill in numbers:

$a = \frac{600 \text{ m/s}}{2 \text{ sec}}$

Answer with units:

$a = 300 \text{ m/sec}^2$

2b. How much force is required to accelerate the rocket?

Knowns:

$M = 500$ kg

$a = 300 \text{ m/sec}^2$

Unknown:

F_{net}

Equation:

$F_{net} = m \cdot a$

Fill in numbers:

$F_{net} = 500\text{kg} \cdot 300 \text{ m/sec}^2$

Answer with units:

$F_{net} = 150{,}000$ N

2c. How much force would be required to accelerate the rocket if it's mass were twice as much (1000 kg)?

Knowns:

$M = 1000$ kg

$a = 300 \text{ m/sec}^2$

Unknown:

F_{net}

Equation:

$F_{net} = m \cdot a$

Fill in numbers:

$F_{net} = 1000\text{kg} \cdot 300 \text{ m/sec}^2$

Answer with units:

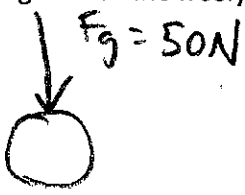
$F_{net} = 300{,}000$ N

2d. Why is payload (the amount of material a rocket carries into space) of extreme importance to rocket scientists?

The more payload a rocket carries, the more force is required is needed to propel the rocket. That requires more rocket fuel, which is expensive!

3. A boy drops a 5 kg ball off a bridge. Ignoring air resistance, answer the following questions.

3a. Draw a force diagram for the freely falling ball.



3b. What is the net force on the ball?

50N down

3c. What is the acceleration of the ball?

Knowns:

$M = 5$ kg

$F_{net} = 50$N

Unknown:

a

Equation:

$a = \frac{F_{net}}{m}$

Fill in numbers:

$a = \frac{50\text{N}}{5\text{kg}}$

Answer with units:

$a = 10 \text{ m/sec}^2$

3d. How fast is the ball moving after it has been falling for 2 seconds?

Knowns:

$a = 10 \text{ m/sec}^2$

$\Delta t = 2$ sec

Unknown:

V

Equation:

$V = a \Delta t$

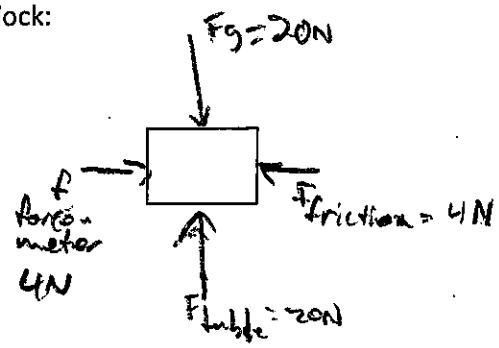
Fill in numbers:

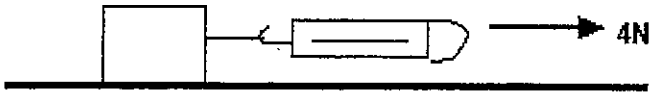
$V = 10\text{m/sec}^2 \cdot 2\text{sec}$

Answer with units:

$V = 20$ m/s

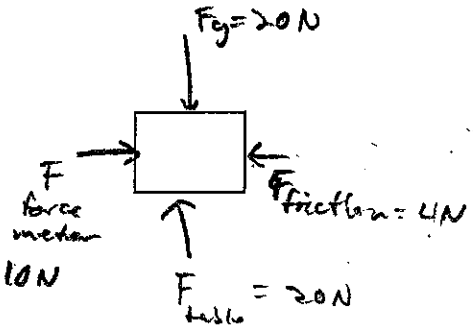
4. A 2 kg block is dragged across a table top at a **constant velocity** by means of a spring scale (force meter) attached horizontally to the block. The scale shows a reading of 4 N at any constant velocity. This means that the frictional force between the block and the table is 4 N, and is not dependent on speed. Draw the forces on the block:





Net force = 0N

4b. The block is now pulled with a constant force of 10 N, which accelerates the block across the table top. Draw the forces on the block:



Net force = 6N

4c. What is the acceleration of the block due to this net force?

Equation: $a = \frac{F_{net}}{mass}$

Fill in #: $a = \frac{6N}{2kg}$

Answer: $a = 3\ m/sec^2$

5. A rocket in space has a mass of 5000 kg, and is propelled by a rocket motor with 900,000 N of thrust, which burns for 4 seconds.

5a. What is the rocket's acceleration?	5b. If the rocket starts at rest, how fast is the rocket going after the 4 second burn?
Knowns: $m = 5000kg$, $F_{net} = 900,000\ N$	Knowns: $a = 190,000\ m/sec^2$, $\Delta t = 4sec$
Unknown: a	Unknown: V
Equation: $a = \frac{F_{net}}{m}$	Equation: $V = a\Delta t$
Fill in numbers: $a = \frac{900,000N}{5000kg}$	Fill in numbers: $V = 190000\ m/sec^2 \cdot 4sec$
Answer with units: $a = 190,000\ m/sec^2$	Answer with units: $V = 760,000\ m/sec^2$

6. A satellite in space fires its thrusters for 10 seconds to give itself an added velocity of 2 m/sec. Its constant thrusting force is 800 N during this time.

6a. What is the satellites's acceleration?	6b. What is the mass of the satellite?
Knowns: $\Delta T = 10\,s$ $\Delta V = 2\,m/s$ $F_{net} = 800\,N$	Knowns: $F_{net} = 800\,N$ $A = 0.2\,m/s^2$
Unknown: A	Unknown: Mass
Equation: $A = \frac{\Delta V}{\Delta T}$	Equation: $Mass = \frac{F_{net}}{A}$
Fill in numbers: $= \frac{2\,m/s}{10\,s}$	Fill in numbers: $= \frac{800\,N}{0.2\,m/s^2}$
Answer with units: $A = \boxed{0.2\,m/s^2}$	Answer with units: $= \boxed{4000\,kg}$

7. A volleyball player serves a 0.25 kg ball, giving it an acceleration of 150 m/s^2.

7a. What is the force applied to the ball?	7b. If the player accelerates the ball for 0.1 s, how fast is it going when it leaves her hand? (assume no friction)
Knowns: $M = 0.25\,kg$ $A = 150\,m/s^2$	Knowns: $\Delta T = 0.1\,s$ $A = 150\,m/s^2$
Unknown: F_{net}	Unknown: ΔV
Equation: $F_{net} = M \cdot A$	Equation: $\Delta V = A \cdot \Delta T$
Fill in numbers: $= 0.25\,kg \cdot 150\,m/s^2$	Fill in numbers: $= 150\,m/s^2 \cdot 0.1\,s$
Answer with units: $= \boxed{37.5\,N}$	Answer with units: $= \boxed{15\,m/s}$