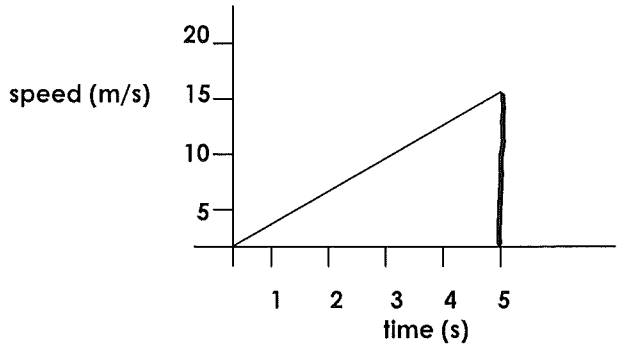
Name _____ Hour _____

1-D Motion:

1. Use the graph below to answer the following questions:



a. What is the slope of the line? What does the slope represent? $15/5 = 3\ m/s^2$ = acceleration

b. What unit do you end up with if you multiply speed x time? $m/s \cdot s = m$

c. Use a 1-D equation to determine how far the object traveled in 5 seconds? (37.5 m)

$\Delta x = v_i \Delta t^0 + \frac{1}{2} a \Delta t^2$

$\Delta x = \frac{1}{2}(3)(5)^2 = 37.5\ m$

2. A cat is dropped from rest on a planet on which the acceleration due to gravity is not known. If the cat falls 2.1 meters in 1.0 sec, how far will the cat have dropped at the end of 6 seconds? ***(ans. -75.6 m)***

① $-2.1 = v_i \Delta t^0 + \frac{1}{2} a (1)^2$

$a = -4.2\ m/s^2$

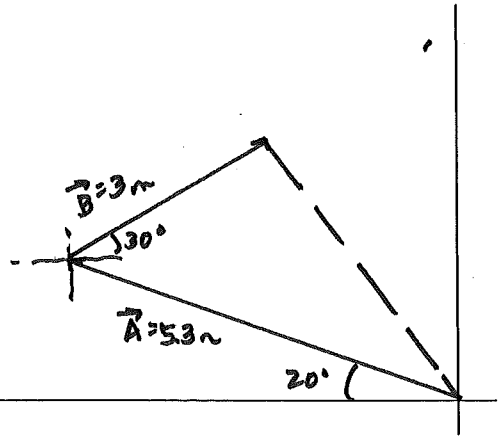
② $\Delta y = v_i \Delta t^0 + \frac{1}{2}(-4.2)(6)^2$

$\Delta y = -75.6\ m$

Vectors:

3. Add the following vectors graphically: **A** = 5.3 m at 20°N of W, **B** = 3 m at 30°N of E
(about 4.1m at 35.7° W of N)

R = 4.1m at 36° W of N



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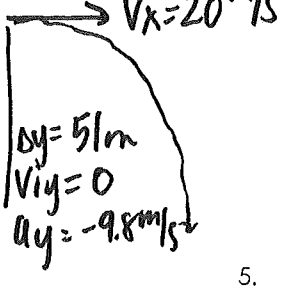
Projectile Motion:

4. A plane that is delivering insecticides to crops is traveling horizontally at 20 m/s at a height of 51 meters. The pilot is aiming for a particular spot on the field below. How far (Δx) before he is over that spot should the pilot drop the insecticides? ***(ans. 64.5 m)***



① $\Delta y = Viy\Delta t + \frac{1}{2}a_y\Delta t^2$

$-51 = \frac{1}{2}(-9.8)\Delta t^2$

$\Delta t = 3.23 sec$

② $Vx = \frac{\Delta x}{\Delta t}$

$20 = \frac{\Delta x}{3.23}$

$\Delta x = 64.5 m$

5. A baseball is hit at 30.0 m/s at an angle of 53° N of E.
   a. Calculate how far it traveled horizontally. (88m)

① solve Viy, Vx

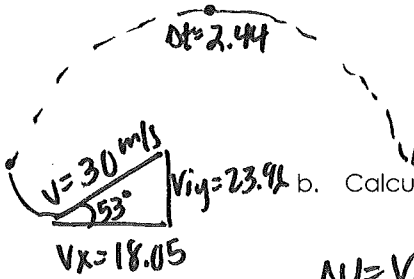
② Find Δt at ½ way pt (Δt=2.44sec)

$a_y = \frac{v_f - Viy}{\Delta t}$

③ $Vx = \frac{\Delta x}{\Delta t}$

$18.05 = \frac{\Delta x}{4.88}$

$\Delta x = 88.1 m$



   b. Calculate its maximum height. (29.3 m)

$\Delta y = Viy\Delta t + \frac{1}{2}a_y\Delta t^2$

$23.96(2.44) + \frac{1}{2}(-9.8)(2.44)^2$

$58.46 - 29.17$

$\Delta y = 29.3 m$

6. You throw a football at some angle N of E, and it lands 28.3 m away 3.0 sec later. Find the velocity and the angle of the ball in **miles per hour** just as it leaves your hand. You will first need to find Vx and Viy before you can find the V. *(39 mph at 57° N of E)*

① solve $Vx = \frac{\Delta x}{\Delta t} = \frac{28.3}{3} = 9.43 m/s$

② solve Viy

$a_y = \frac{v_f - Viy}{\Delta t}$

(at ½ way pt)

$-9.8 = \frac{0 - Viy}{1.5}$ $Viy = 14.7 m/s$

Vx = 9.43 m/s
Viy = 14.7 m/s
V = 17.49 m/s = 39.1 mph
θ = 57.2°

③ $V^2 = Vx^2 + Viy^2$

④ $\tan\theta = \frac{Viy}{Vx}$

Newton's Laws of Motion:

7. A 2,000-**pound** car initially traveling at 46 **mph** takes 2.4 seconds and 14 meters to stop. Find the force needed to stop the car. (-7,800 N. Why is it negative?)

$m = \frac{2000}{2.2} = 909.1 kg$

$Vi = 46 mph = 20.56 m/s$

$\Delta t = 2.4 sec$

$\Delta x = 14 m$

$Vf = 0$

① find a

$a = \frac{Vf - Vi}{\Delta t}$

$(-8.57 m/s^2)$

② $F = m \cdot a$

(-7788N)

negative because slowing down, working against motion

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8. You (mass 55 kg) and your friend (mass 60 kg) experience 1,120 N of force at the bottom of the hill on a rollercoaster. How many g's is this for you and for your friend? (2.08 and 1.9)

you: $\frac{1120}{55(9.8)} = 2.07$ g's friend = $\frac{1120}{55(9.8)} = 1.9$ g's

Work and Energy:

9. A 2,000 **lb.** car goes from 0 to 20 m/s in 4.2 seconds. Calculate the horsepower of the engine. (58 hp)

$m = \frac{2000}{2.2} = 909.1$ kg
$V_i = 0$
$V_f = 20$ m/s
$\Delta t = 4.2$ sec

① Solve a: $a = \frac{V_f - V_i}{\Delta t}$ (4.76 m/s²)

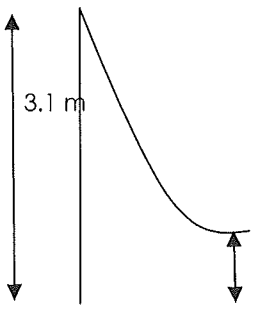
② $F = m \cdot a$ (4329 N)

③ $W = F \cdot d$ (18174.6 J)

④ $P = \frac{W}{\Delta t}$
43273 watts $\times \frac{1\ hp}{746} =$ **58 hp**

$\Delta x = V_i \Delta t^0 + \frac{1}{2} a \Delta t^2$
$\frac{1}{2}(4.76)(4.2\text{sec})^2 = 42$m

10. A hot wheel car (mass=15.5 g) starts from rest 3.1 m above the ground and slides down a track as shown below. It leaves the track horizontally at 1.2 m off the ground. Calculate how far away (Δx) from the base of the ramp it will land. (Use CE to find Vf , then car turns into a horizontal projectile with Vf=Vx and Δy = 1.2 m) (3.01 m)

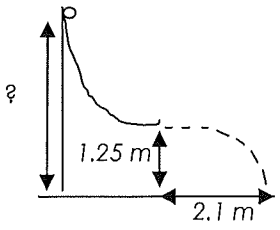


① CE to find Vf (Vf=Vx)
$ghi + \frac{1}{2}V_i^2 = ghf + \frac{1}{2}V_f^2$
$ghi = \frac{1}{2}V_f^2 + ghf$
$9.8(3.1) = \frac{1}{2}V_f^2 + 9.8(1.2)$
$18.62 = \frac{1}{2}V_f^2$
$V_f = 6.1$ m/s

② $\Delta y = V_{iy}\Delta t^0 + \frac{1}{2}a_y\Delta t^2$
$-1.2 = \frac{1}{2}(-9.8)\Delta t^2$
$\Delta t = 0.49$ sec

③ $V_x = \frac{\Delta x}{\Delta t}$ $6.1 = \frac{\Delta x}{.49\text{sec}}$
Δx = 3.02 m

11. A ball with a mass of 522 **grams** starts from rest and rolls down a track. If it leaves the track horizontally, at what height (Δy) above the ground was the ball when it started? Solve using conservation of energy and projectiles. (2.1 m)



① Δy = to find Δt (0.51sec)
② $V_x = \frac{\Delta x}{\Delta t}$ to find Vx (Vx=Vf) = 4.12 m/s
③ CE to find hi (hi=2.1m)

Momentum:

12. A 0.25 kg softball initially moving at 18 m/s is caught by a pitcher. The pitcher brings it to a stop in 0.2 seconds. What force does the pitcher need to exert to stop it? (-22.5 N)

$F\Delta t = m\Delta v$

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13. You (mass 50 kg) and a friend (mass 60 kg) are skating and push off of each other. If you travel at 3 m/s backwards, at what speed will your friend travel at? (2.5 m/s)

$m_1 v_1 = m_2 v_2$

14. A 5-kg bowling ball traveling at 2.4 m/s strikes a stationary 2.5- kg pin which moves off at 3.3 m/s. Find speed of the bowling ball after the collision. (0.75 m/s)

$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$ ($m_2 v_{2i} = 0$)

$5(2.4) = 5x + (2.5)(3.3)$

Circular Motion and Gravity:

15. Let's say you weigh 153 pounds on the earth's surface. Calculate your weight (in N) if you traveled to a distance that is 4,000 **miles** above the surface of the earth. ***(169.1 N)***

$m = \frac{153 \text{ lb}}{2.2} = 69.55 \text{ kg}$ $r = 4000 \text{ mi} \times \frac{1609 \text{ m}}{1 \text{ mi}} = 6436000 + 6.37 \times 10^6 = 12806{,}000 \text{ m}$ ② $w = m \cdot g$

① $g = \frac{Gm}{r^2}$

$(g = 2.43 \text{ m/s}^2)$

16. You (mass = 100 kg) are riding the swings at MOA. If the radius of the ride is 3.5 m and your velocity hits 15 mph, find your **centripetal force** and **# of g's**. (1284 N, 1.31 g's)

$15 \text{ mph} = 6.7 \frac{\text{m}}{\text{s}}$ ① $F_c = \frac{mv^2}{r}$ ② $g's = \frac{1284 \text{ N}}{100(9.8)} = 1.31 \text{ g's}$

(1284 N)

17. Calculate how long a pendulum would need to be on the moon in order to have a period of 2.4 sec. (0.24 m)

$L = 0.24 \text{ m}$

$T^2 = \frac{4\pi^2 L}{g}$

$2.4^2 = \frac{4\pi^2 L}{1.62}$