

# PHYSICS MID TERM FORMULAS

CONVERSIONS :            1 km/hr is 5/18 meters per second exactly  
                                   1 km is 1000 meters, 1 hr is 3600 seconds  
                                   1 meter/second is 2.236936292054402 miles/hour  
                                   1 mph = 0.44704 m/s

General Equations of motion (for constant acceleration)

$$D = \frac{(V_i + V_f) \cdot T}{2} \qquad V_f = V_i + A T$$

$$D = V_i T + \frac{1}{2} A T^2$$

$$V_f^2 = V_i^2 + 2 A D$$

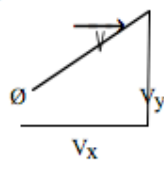
$g = A = 9.81 \text{ m/s/s}$

For Projectiles/Vectors:     $T_x = T_y$ ,     $A_x = 0$ , usually, so

Pythagorean:  $(\vec{V})^2 = V_x^2 + V_y^2$

$$V_x = \vec{V} \cos(\theta)$$

$$V_y = \vec{V} \sin(\theta)$$

$$\theta = \tan^{-1}(V_y/V_x)$$


X	Y
$D_x = V_{ix} T$	$D_y = V_{iy} T + \frac{1}{2} A_y T^2$
$D_x = \vec{V} \cos(\theta) T$	$D_y = \vec{V} \sin(\theta) T + \frac{1}{2} A_y T^2$
	$V_{fy}^2 = V_{iy}^2 + 2 A_y D_y$
	$V_{fy} = V_{iy} + A_y T$

$V_{fy}$  at top = zero,  $T = 1/2 T_f$  if  $D_y = 0$  (up then down)

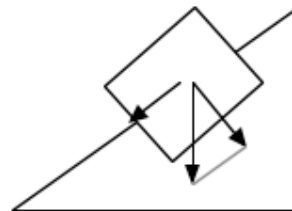
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 F(net) = Sum all forces on object F(net) could be  
 F(net) = Tension-Weight, or F(net) = Pull-Friction, or F(net) = Parallel Force-Pull-friction, etc....  
 NL I: Inertia  
 NL II F(net) = mA

$W = mg$

NL III  $F_1 = F_2$

Force(Friction) =  $\mu F$ (Normal)  
 $\mu = F_f / F_N$  where  $\mu$  is the coefficient of friction between two surfaces.

ON RAMP:  
 Perpendicular Force =  $W \cos \theta$   
 Sliding Force = Parallel Force =  $W \sin \theta$



## MIDTERM REVIEW ANSWERS

### EXAMPLE WORD PROBLEMS: PRACTICE DRAWING PICTURES AND LISTING VARIABLES!!!!

Police find skid marks of 50 meters on a road from a car that has a maximum deceleration of  $-40 \text{ m/s}^2$ . Was the car exceeding the  $20 \text{ m/s}$  speed limit?  
How long did it take the car to stop?

$$\begin{aligned}D &= 50 \\A &= -40 \\V_f &= 0 \\V_i &= ???, T = ??? \\V_f^2 &= V_i^2 + 2 A D \\V_i &= \text{sqrt}(2 * 40 * 50) \\V_i &= 63.2 \text{ m/s yes,} \\V_f &= V_i + AT \quad T = 63.2/40 \quad T = 1.58 \text{ sec}\end{aligned}$$

If an object is dropped from a tower and it hits the river 20 seconds later, how high is the tower?

$$\begin{aligned}V_i &= 0, T = 20, A = -9.8 \\D &= V_i T + \frac{1}{2} A T^2 \\D &= 0 - 4.9 * (20)^2 \\D &= 1960 \text{ m}\end{aligned}$$

If a diver dives off of a platform that is 20 meters above the pool with an upwards velocity of 0.5 meters per second, what is the final velocity of the diver as he hits the water, and how long till he hits the water?

$$\begin{aligned}V_i &= +0.5, A = -9.8, D = -20 \\V_f^2 &= V_i^2 + 2 A D \\V_f &= \text{sqrt}(.5^2 - 2 * -9.8 * -20) \\V_f &= -19.8 \text{ m/s,} \\V_f &= V_i + AT \quad T = (-19.8 - .5) / -9.8 / 40, T = 2.072 \text{ sec}\end{aligned}$$

A 4500 kg car is traveling along a surface with the coefficient of friction of 0.4 at a speed of  $54 \text{ m/s}$ . He sees the light and slams on his brakes, locking the tires and skids to a halt.... What is the distance he travels before he halts?

$$\begin{aligned}m &= 4500 \\W &= mg = 4500 * 9.8 = 44100 \text{ N} \\F_N &= W = 44100 \\F_f &= .4 (44100) = 17640 \text{ N} \\F_{\text{net}} &= F_p - F_f = F_f = 17640 \text{ N} \\F_{\text{net}} &= ma \\17640 &= 4500 a \\a &= -3.92\end{aligned}$$

$$\begin{aligned}
V_i &= 54 \\
V_f &= 0 \\
V_f^2 &= V_i^2 + 2 A D \\
0 &= 54^2 + 2 * -3.92 * D \\
D &= 2916 / 7.84 = 371.94 \text{ m} \\
D &= 371.94 \text{ m}
\end{aligned}$$

An arrow is shot in the air with a velocity of 61 meters per second at an angle of 20 degrees. How high will the arrow go?

$$\begin{aligned}
D_y &= 22.2 \text{ m} \\
V_x &= 61 \cos 20 = 57.32 \\
D_x &= V_x T
\end{aligned}$$

$$\begin{aligned}
V_{iy} &= 61 \sin 20 = 20.86 \\
A &= -9.8 \\
\text{At top } V_{fy} &= 0 \\
V_{fy} &= V_{iy} + A_y T \\
0 &= 20.86 - 9.8 * T \\
T &= 2.13 \text{ sec}
\end{aligned}$$

$$\begin{aligned}
V_f^2 &= V_i^2 + 2 A D \\
0 &= 20.86^2 + 2 * -9.8 * D \\
D &= 435.27 / 19.6 = 22.2 \text{ m}
\end{aligned}$$

A truck is stopped at a stoplight. When the light turns green, it accelerates at  $2 \text{ m/s}^2$ . At the same instant, a car passes the truck going  $30 \text{ m/s}$ . Where and when does the truck catch up with the car? draw the accurate distance time and velocity time graph

$$\begin{aligned}
\text{Truck, } v_i &= 0, A = 2 \\
D &= V_i T + 1/2 A T^2 \\
D &= 1/2 * 2 * T^2
\end{aligned}$$

$$\begin{aligned}
\text{Car, } A &= 0, V_i = 30 \\
D &= 30T
\end{aligned}$$

$$\begin{aligned}
\text{So car} &= \text{truck} \\
30T &= 1T^2 \\
T &= 30, D = 30 * 30 = 900 \text{ m} \\
T &= 30 \text{ sec, } D = 900 \text{ m}
\end{aligned}$$

What is the mass of a brick that I need 800 Newtons of force to lift upwards and accelerate at  $2 \text{ m/s}^2$  ?

$$\begin{aligned}
F_{\text{net}} &= mA = F_{\text{up}} - W \\
ma &= F_{\text{up}} - mg \\
m(2) &= 800 - m(9.8) \\
m(11.8) &= 800
\end{aligned}$$

$$m=800/11.8=67.8 \text{ kg}$$

A 50 Kg block sits on a 45 degree ramp and starts sliding down. If the ramp has a coefficient of friction of .5, what acceleration does the block have as it slides down the ramp?

$$M=50$$

$$W=50*9.8=490$$

$$FN=490\cos45=346.48 \text{ N}$$

$$Ff=.5 (346.48) =173.24 \text{ N}$$

$$Fp=490\sin45=346.48 \text{ N}$$

$$F_{net}=Fp-Ff = 346.38 -173.24=173.24 \text{ N}$$

$$F_{net}=ma$$

$$173.24 = 50 a$$

$$A=3.465 \text{ m/s}^2$$