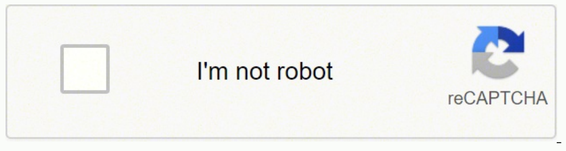


Open

Kinematic equations worksheet

Physics 151 – Exam Equation Sheet

Exam 1 Equations

Unit Conversions

1 m = 1.094 yd = 3.281 ft = 39.4 in
1 mile = 1609 m
1 in = 2.54 cm

Constants

g = 9.81 m/s^2 = 32.0 ft/s^2

c = 2.99 x 10^8 m/s

Geometric Formulae

Circle

$C = 2\pi r$

$A = \pi r^2$

Rectangle

$P = 2(l + w)$

$A = l \times w$

Cube

$A = 6l^2$

$V = l^3$

Sphere

$A = 4\pi r^2$

$V = \frac{4}{3}\pi r^3$

Cylinder

$A = 2\pi r^2 + 2\pi rl$

$V = \pi r^2 l$

Triangle Trigonometry

$\sin\theta = \frac{opp}{hyp}$

$\cos\theta = \frac{adj}{hyp}$

$\tan\theta = \frac{opp}{adj}$

1-D Kinematics

$average\ speed = \frac{distance}{elapsed\ time}$

$average\ velocity = \frac{displacement}{elapsed\ time}$

If a = 0

then $x = vt$

If a ≠ 0

then

$v = v_0 + at$

$x = \frac{1}{2}(v_0 + v)t$

$x = v_0 t + \frac{1}{2}at^2$

$v^2 = v_0^2 + 2ax$

Horizontal Range

$R = \left(\frac{v_0^2}{g}\right)\sin 2\theta$

Kinematics Worksheet (Part 2) Name:_____KEY_____
Date:_____
Mod:_____

Directions: Answer the following motion problems using the kinematic equations. Show your work and circle your final answer.

1. A speedboat increases in speed uniformly from 20m/s to 30m/s in a distance of 200m. What is the acceleration of the speedboat?

$v_f = 30\frac{m}{s}$ $v_f^2 = v_i^2 + 2ad$
$v_i = 20\frac{m}{s}$ $a = \frac{v_f^2 - v_i^2}{2d}$
$a = ?$ $a = \frac{(30\frac{m}{s})^2 - (20\frac{m}{s})^2}{2(200m)}$
$t = xxx$
$d = 200m$ $a = 1.25\frac{m}{s^2}$

2. A driver in a car traveling at a speed of 60 mi/hr sees a deer in the middle of the road 100m away. What is the minimum constant acceleration that is necessary for the car to stop?

$v_f = 0\frac{m}{s}$ $\frac{1609m}{1hr} * \frac{1hr}{60min} * \frac{1min}{60s} * \frac{1m}{1000m} * \frac{100cm}{1m} * \frac{1in}{2.54cm} = 26.82\frac{m}{s}$
$v_i = 26.82\frac{m}{s}$ $v_f^2 = v_i^2 + 2ad$
$a = ?$ $a = \frac{v_f^2 - v_i^2}{2d}$
$t = xxx$
$d = 100m$ $a = \frac{(0\frac{m}{s})^2 - (26.82\frac{m}{s})^2}{2(100m)}$
$a = -3.66\frac{m}{s^2}$

3. Julie is walking around a track at a 2m/s for some exercise. She then decides to start jogging so she accelerates at a rate of 0.5m/s^2 for 3 seconds. How far did Julie travel from the time she started to accelerate to the end of the 3 seconds?

$v_f = xxx$ $d = v_i t + \frac{1}{2}at^2$
$v_i = 2\frac{m}{s}$ $d = \left(2\frac{m}{s}\right)(3s) + \frac{1}{2}\left(0.5\frac{m}{s^2}\right)(3s)^2$
$a = 0.5\frac{m}{s^2}$
$t = 3s$
$d = ?$ $d = 8.25m$

4. A rocket accelerates at a rate of 16.4m/s^2 for a distance of 50m. What is the velocity at the end of the 50m?

$v_f = ?$ $v_f^2 = v_i^2 + 2ad$
$v_i = 0\frac{m}{s}$ $v_f = \sqrt{v_i^2 + 2ad}$
$a = 16.4\frac{m}{s^2}$ $v_f = \sqrt{0 + 2(16.4\frac{m}{s^2})(50m)}$
$t = xxx$
$d = 50m$ $v_f = 40.5\frac{m}{s}$

Time-independent relationship between Δx, v and a

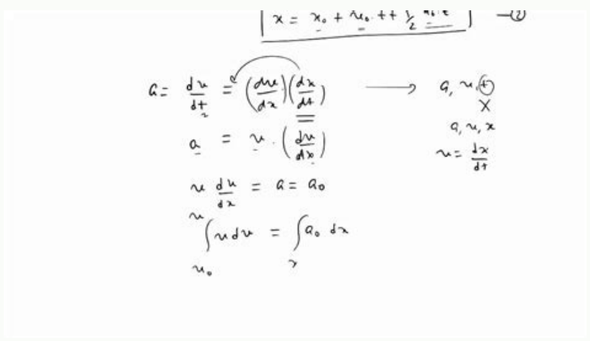
We have defined acceleration as:

$$\bar{a} = \frac{\Delta v}{\Delta t}$$

This can be rearranged to:

$$\Delta t = \frac{\Delta v}{\bar{a}}$$

and then expanded to yield : $$\Delta t = \frac{v_f - v_0}{\bar{a}}$$



ANGLES AND TRIANGLES

Degrees and Radians

$\frac{\theta_d}{180^\circ} = \frac{\theta_r}{\pi\ rad}$

Degrees × $\frac{\pi^r}{180^\circ}$ = Radians

Radians × $\frac{180^\circ}{\pi}$ = Degrees

Angles and Arcs

θ in Degrees

$\frac{\theta}{360^\circ} = \frac{s}{C}$

C (circumference)

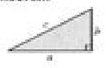
θ in Radians

$\theta = \frac{s}{r}$

$s = r\theta$

Pythagorean Theorem

$a^2 + b^2 = c^2$



Similar Triangles

$\frac{a}{a'} = \frac{b}{b'} = \frac{c}{c'}$

TRIGONOMETRIC FUNCTIONS ACCURACY FOR TRIANGLES

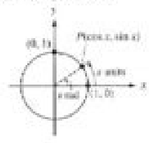
Trigonometric Functions

$\sin x = \frac{b}{r}$ $\csc x = \frac{r}{b}$

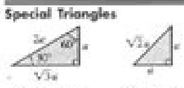
$\cos x = \frac{a}{r}$ $\sec x = \frac{r}{a}$

$\tan x = \frac{b}{a}$ $\cot x = \frac{a}{b}$

(x in degrees or radians)
For x any real number and T any trigonometric function,
T(x) = T(x rad)
For a unit circle:



Special Triangles



Special Values

θ	sin θ	csc θ	cos θ	sec θ	tan θ	cot θ
0° or 0	0	N.D.	1	1	0	N.D.
30° or π/6	1/2	2	√3/2	2√3	1/√3	√3
45° or π/4	1/√2	√2	1/√2	√2	1	1
60° or π/3	√3/2	2√3	1/2	2	√3	1/√3
90° or π/2	1	1	0	N.D.	N.D.	0

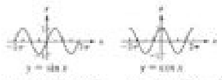
N.D. = Not defined

Accuracy for Triangles

Angle to Nearest	Significant Digits for Side Measure
1°	2
10' or 0.1°	3
1' or 0.01°	4
10" or 0.001°	5

TRIGONOMETRIC FUNCTION GRAPHS INVERSE FUNCTIONS

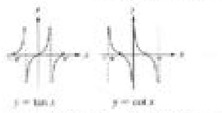
Graphing Trigonometric Functions



$y = A\sin(Bx + C)$ $y = A\cos(Bx + C)$

Amplitude = |A| Period = $\frac{2\pi}{B}$ Frequency = $\frac{B}{2\pi}$

Phase shift = $-\frac{C}{B}$ $\begin{cases}\text{left} & \text{if } -C/B < 0\\ \text{right} & \text{if } -C/B > 0\end{cases}$



$y = A\tan(Bx + C)$ $y = A\cot(Bx + C)$

Period = $\frac{\pi}{B}$ Phase shift = $-\frac{C}{B}$ $\begin{cases}\text{left} & \text{if } -C/B < 0\\ \text{right} & \text{if } -C/B > 0\end{cases}$

Inverse Trigonometric Functions

$y = \sin^{-1} x$ means $x = \sin y$

where $-\frac{\pi}{2} \le y \le \frac{\pi}{2}$ and $-1 \le x \le 1$

$y = \cos^{-1} x$ means $x = \cos y$

where $0 \le y \le \pi$ and $-1 \le x \le 1$

$y = \tan^{-1} x$ means $x = \tan y$

where $-\frac{\pi}{2} < y < \frac{\pi}{2}$ and x is any real number

$y = \cot^{-1} x$ means $x = \cot y$

where $0 < y < \pi$ and x is any real number

$y = \sec^{-1} x$ means $x = \sec y$

where $0 \le y \le \pi, y \ne \frac{\pi}{2}$, and $x \le -1$ or $x \ge 1$

$y = \csc^{-1} x$ means $x = \csc y$

where $-\frac{\pi}{2} \le y \le \frac{\pi}{2}, y \ne 0$, and $x \le -1$ or $x \ge 1$

A balloon rises from rest on the ground vertically upwards with a constant acceleration object G / 8.A is removed from the balloon when H.Enfind has been raised at the time taken by the object to reach the ground. v =? We are writing the equation at the same time T variable $ v_2 = V_0 - G (T-2) $ and $ Y_2 = V_0 (T-2) - \ Frac {1} {2} G (T-2) ^ 2 - - (2) Now, when there are between SÃ, then $ Y_1 = Y_2 $ V_0T- \ Frac {1} {2} (GT ^ 2) = V_0 (T-2) - \ Frac {1} {2 } G (T-2) ^ 2 $ Resolving $ t = \ Frac {V_0} {G} + 1 = 5.09 * SEC Substitute this value in any previous equation will give the value of the height $ H = 40 \ Times 5.09- \ Frac {1} {2} (9.8} Times 5.09 \ Times 5.09) = 76.6 $ m The respective speeds can be found using the first set of each equation 1 and 2 for the first object $ V_1 = V_0 - GT = 40- (9.8 \ Times 5.09) = - 9,882 $ m / s for the second object $ V_2 = V_0 - G (T-2) = 40-9.8 (5.09-2) = 9,718 $ / sec Question 4. Thus the height Total above the ground will be = 6 + 13.6 = 19.6 m d. C. Speed (V) = 20 m / s Time (T) =? Find the acceleration in the T = 0 and T = 1 SEC now first step to try that the question is to visualize the entire process. What is the elevator from the bottom of the bottom of the axis when the nut fell? B. Find out the speed and acceleration vector for particle b. What will it be the speed of the bullet with respect to another police motorcycle that was moved in the same direction at a speed of speed of speed of the motorcycle motorcycle WRT Ground = $ v_M $ speed of the Bullet WRT to motorcycle or snout = $ V_B $ Bullet speed WRT Ground = speed of bullet W RT a motorcycle + speed of motorcycle WRT to ground therefore, speed of Bullet WRT to the floor = $ V_B + V_M $ Speed with Bullet Golite the Thief = de Bullet WRT - Velocidad del ladrÃ³n WR T Ground = $ V_B + V_M- V_T $ VELOCIDAD DE LA BULLET WR T OTRO MOTORCOCLE = VELOCIDAD DE LA MOTORCOCLE = $ V_B + V_M - V $ Pregunta 7. $ V ^ 2 = u ^ 2 + 2ah $ desde la perspectiva de la tuerca u = 3m / s a ãâ= -g = -9.8m / s2 s2 si h erehW $2^tg }2{}1{ carf\ -t }hg{ trqs\ =h-$,evitisop sa noitcerid drawpu gnikaT ?=a .a noituloS 2s/m 8.9=g neviG .sixa evitisop eht sa noitcerid drawpu dna tcejbo eht fo noitisop laitini eht ta nigiro eht ekat teL noituloS teem yeht nehw tcejbo hcae fo seiticolev eht era tahw.c teem yeht nehw emit eht si tahw.b teem yeht thgieh tahw tA.a gniwollof tuo dniF .a enil thgiarts a gnola sevom suB.2ces/m2 noitarelecca mrofinu htiw tser morf A noitatS ta trats sub A .rotavele morf ffo llef tun eht nehw woleb m 6.31 saw tfahs eht fo mottob eht oS m $6.31-= 2 semit\ 2 semit\ )8.9-(semit\ }2{}1{ carf\ + 2 semit\ 3=H$ $2^tg}2{}1{ carf\ +t0_v =H$ oS 2=t dnuorg eht tih ot emit woN 2s/m $8.9-=g-=a$ dna 0=t ta s/m$ 3=0_v$ nehT noitcerid evitisop eht sa noitcerid drawpu ekat teL .e .drawpu sa yticolev laitini eht rebmemer ew fi esnes sekam sihT ?ffo llef eht retfa yticolev orez sah tun ,tfahs eht fo mottob eht evoba thgieh tahw tA .a gniwollof eht dnif 2s/m 2.1 fo noitarelecca tnatsnoc htiw seunitnoc dna drawrof sevom sub eht,0=t ta rood eht dniheb m 6 si eh nehW .noitauqe noitarelecca eht dnif tsrif ot deen ew ,noitauqe yticolev eht gnivah era ew woN 1=t .b m $c+b+a=x$ $3^)1(c+2^)1(b+)1(a=x$ rewsna eht teg ew noitauqe nevig ni 1=t gnitutitsbus yb ereH ces1=t .b ces 1=t ta tnemecalpsid eht dniF .sa denialpxe eb nac sihT. snoitulos evitisop owt era ereh etoN s 4.4 dna 3.2 =t alumroF citardauQ eht gnivloS $0=03+t02-2^t3$ ro $2^t6.+6=t4 $ os $b_x=m_x$ sub eht sehctac nam eht nehW $2^t6.+6=b_x$ $t4=m_x$ suhT 2s/m $2.1=b_a$, $0=m_a$, $0=}0b{_v$, s/m $4=}0m{_v$ era nevig woN $2^t b_a}2{}1{ carf\+}0b{_v+}0b{_x=b_x$ $2^t m_a}2{}1{ carf\ +}0m{_v+}0m{_x=m_x$ sub eht dna nam eht rof noitom fo noitauqe ehT m $6=}0b{_x$ ta neht si rood sub ehT.$0=}0m{_x$ nigiro eht eb noitisop s'nam tel 0=t tA noituloS .d 0=t ta tnemecalpsid eht si tahw .e m1.41=54.+6.31=tfahs fo mottob eht evoba thgieh latoT oS m54.= 8.9*2/3*3=H ro $Hg2=2^u$ 0=v as we have taken upward as positive axis , t is the time taken taken to reach the ground and acceleration is -g as gravity is active downwards Equation can be written in the form $gt^2-\sqrt {gh} t-2h=0$ Solving this equation and taking positive root $t=2 \sqrt {\frac {h}{g}}$ Question 6. How much time it will take to cover a distance of 1.6km Solution Now first step to attempt such question is to visualize the Distance (s)=? what is the velocity at t=0,t=1 b. What is the speed of the bullet with respect to the observer sitting on the ground? t=1 Here we are having the displacement equation, so first we need to find out the velocity equation So here the most suitable formula is $v= \frac {dx}{dt}$ or $v=\frac {d}{dt}(at+bt^2+ct^3)$ or $v=a+2bt+3ct^2$ Substituting t=0 we get $v=a$ m/s Substituting t=1 we get $v=a+2b+3c$ m/s c. Here the object is moving along a straight line and its motion is described by the given equation Now we $x=at+bt^2 + ct^3$ Now since its motion is described by the given equation, following formula will be useful in determining the values $x=\int vdt$ $v=\int adt$ $v= \frac {dx}{dt}$ $a=\frac {dv}{dt}= \frac {d^2x}{dt^2}$ $a=v \frac {dv}{dx}$ a. The motion of that object is described by $x=at+bt^2 + ct^3$ where a,b,c are constants and x is in meters and t is in sec. Equation of motion is given by $x=pt(1-qt)$ Velocity = $\frac {dx}{dt}$ So $v=p(1-2qt)$ Acceleration = $\frac {dv}{dt}$ So $a=-2pqt$ Hence, Velocity vector= $p(1-2qt) \mathbf{i}$ Acceleration vector=$-2pqt \mathbf{i}$ b. t=0,v=? Now since it is uniform motion we can use given motion formula's in use $v=u+at$ $s=ut+ \frac {1}{2)}at^2$ $v^2=u^2+2as$ So from equation of motion First object $v_1=v_0 - gt$ and $y_1= v_0t- \frac {1}{2}(gt^2)$ ---(1) Similarly for the second object. So elevator was 13.6 m above the shaft when the nut fell off b. A object is moving along an straight line. Now Let calculate the nut at T = .25 $ H = V_0T + \ FRAC {1} {2} GT^2$ substituting the values as equals above H = .44M, so the nut was above its starting point. A police motorcycle is moving on a road with a speed $ v_m $ shoots a bullet on the burglar motorcycle that accelerates in the same direction with a speed $ v_t (v_t> v_m) $. If the speed of the muzzle of the bullet is $ v_b (v_b> v_t – v_m) $ Discover the following a. The displacement of the body X (in meters) varies with time T (in SEC) as $ x = – \ frac {2} {3} t^ 2 + 16t + 2 $ Find follow a. At what time will it reach its starting point and what will be the total solution of distance traversed to. An object is pulled vertically upwards with an initial velocity of 40 m/s.Two second later, another object is pulled up with the same speed. Time (T) = 10 SEC, so here the most appropriate equation is $ S = UT + \ FRAC {1} {2} at ^ 2 $ substituting given values $ s = (0) 10 + \ frac {1} {2} 2 (10) ^ 2 = 100 m $ b. A nut is released from a bolt at the bottom of the lift, as the lift is moving up the shaft at 3 m/s. Can you find the distance moved by the bus in 10 seconds? Given solution $ x = – \ frac {2} {3} t ^ 2 + 16t + 2 $ (1) velocity = $ \ frac {dx} {dt} = \ frac {-4} {3} T + 16 $ so the velocity at t = 0 = 16 and the velocity at t = 1 = $ \ frac {-4} {3} + 16 = \ frac {44} {3} $ Acceleration is given as = $ \ frac {d ^ 2x} {dt ^ 2} = – \ frac {4} {3} $, so the acceleration is time independent and you can find a constant offset at T = 0, just by substituting the values of T = 0 in equation (1) so, the offset at (t = 0) = 2 now $ v = – \ frac {4} {3} t + 16 $ when v = 0 then you can find $ t = \ frac {4} {3} $ s sec of displacement substituting the value of T = 4/3 in the al al ed ogral ol a eveum es alucÃtrap anU .laer atseupser al se atsE .1 atnugerP .3 atnugerP 2S / M $ C6 + B2 = A $ somibiceR 1 = T odiutitsuS 2S / M $ B2 = A $ somibiceR 0 = t gnitutitsbuS $ TC6 + B2 = A $ $)2 ^ TC3 + TB2 + A(}TD{ }D{ CARF \ = A $ o $ }TD{ }VD{ CARF \ = A $ se adauceda s¡Ãm alumr³Ãf al Ãuqa euq ÃsA .9 atnugerP m $ }72{ }895{ carf \ = }72 { }}45 + 675 + 23-({ carf \ = $ $ 2 + }3{ }46{ carf \ + }72{ }23{ carf \ - = $)1(.5 noitseuQ $}q2{}p{ carf\= }q4{}p{ carf\ + }q4{}p{ carf\ $=delevart ecnatsid latot oS $}q4{}p{ carf\ = td)1- tq2(p }}q{}1{ carf\{^}}q2{}1{ carf\{_tni\ =2_s$ q/1=t ot q2/1=t emit morf delevart ecnatsiD $}q4{}p{ carf\= td)tq2-1(p }}q2{}1{ carf\{^}0{_tni\=1_s$ q2/1=t ot 0=t emit morf delevart ecnatsiD $)1-tq2(p=|v|$=deeps os $0 < v$, $}q2{}1{ carf\ > t$ roF $0=v$, $}q2{}1{ carf\=t$ tA $)tq2-1(p =|v|$=deeps os $0>v$, $}q2{}1{ carf\ < t $ roF taht ees nac ew noitauqe eht morF $)tq2-1(p=v$ ytiolev fo noitauqE noitisop laitini ti hcaer lliw ti, q/1=t ta oS 0=x, $}q{}1{ carf\ =t$ dna 0=x,0=t ta $)tq-1(tp=x$ yb nevig si noitom fo noitauqE .ces 2 ni drawpu m6 evom lliw ti oS drawpu ces/m3=v evitcepsrep rotavele eht woN .2 atnugerP ges 04=t o $2^t)2(}2{}1{ carf\=0061$ $2^ta}2{}1{ carf\ +tu=s$ se adauceda s¡Ãm n³Ãicauce al Ãuqa euq ÃsA .eip ed sºÃbotua nu a ratnaleda arap s/m 4 ed dadicolev anu a erroc erbmoh nU ?adÃac al ed s©Ãupsed otneimivom us ne acreut al rop adirrocer latot aicnatsid al se ¡ÃuC¿Á ?rasnacsed ne adrat es opmeit otn¡ÃuC¿Á .a $sa2+2^u=2^v$ $2^ta}2{}1{ carf\ +tu=s$ $ta+u=v$ sadad otneimivom ed salumr³Ãf razilitu somedop ,emrofinu otneimivom nu se euq odad ,arohA 2ces/m2=n³ÃicarelecA 0=laicini dadicoleV somenet euq ol arohA emrofinu n³Ãicareleca noc y atcer aenÃl ne eveum es sub le ÃuqA ?s ºÃbotua le raznacla zev anugla dadicolev amsim al a ¡ÃerroC ,atreup al ed s¡Ãrted sortem 01 ¡Átse oipicnirp la is .c n³Ãrdal la alab al ¡Ãrad el dadicolev ©Ãuq A¿Á .8 atnugerP m5.41=6.31+54.+54.=tun rop adirrocer latot aicnatsiD ?=x ?oleus la ³Ãyac acreut al odnauc rosnecsa le abatse eje led roirefni etrap al ed amicne rop nat ©ÃuQ¿Á ?ges/m 02 ed res a asap dadicolev al otnemom ©Ãuq nE¿Á .a .a etneiugis ol augirevA .ges 2 ne eje led odnof le aeplog acreut aL .abirra aicah odaznal euf otejbo remirp le odnauc ³Ãznemoc euq opmeit le omoc t opmeit le n©Ãibmat somemoT .0>q ,0 > p Ãy setnatsnoc nos q y p ednod $)tq-1(tp=x$ n³Ãicauce etneiugis al nºÃges What distance above the bottom of the shaft was the nut .25 sec. after the fall? Fall? Displacement when it comes to rest e. t = 0, a =? The first time $ t_1 = 2.3 $ s, corresponds to your first arrival at the door. How long does it take for the man to win door b? Find the velocity at t = 0 and t = 1 sec. Here, the nut initially has the speed of the elevator when it fell. D. Let me take me as the unit vector via the X-axis to. Solution Since the beginning of the balloon is resting, the speed of the balloon when it climbed to height H is given by $ V^2 = u ^2 + 2GH $ $ V^2 = 0 + 2 \ Times \ Frac {G} {8} \ times H $ $ V = \ FRAC {1} {2} \ sqrt {gh} $ When the object is dropped, it has the speed of this same speed in an upward direction. In this worksheet, we will practice the application of the laws of motion of uniform acceleration of a particle in a straight line. So here the most appropriate equation is $ V = U + a $ 20 = 0 + 2T $ or T = 10 SEC C.Distance (s) = 1.6km = 1600m t =? This lesson includes 75 additional questions and 364 variations of additional questions for subscribers. However, the equation we have solved does not know that it will stop running and will board the bus, the equation continued with running at a steady speed. So it goes beyond the bus; But as this is accelerating, it eventually builds a faster speed than the man and will be caught with him at 4.4 sec. If the initial bus position is 10 m, then $ x_m = x_b $ gives $ 3T ^ 2-20T + 50 = 0 $, which only has complex roots, so there are no real-time outputs to which the man picks up the bus link to this page by copying the next Textkine worksheet. Matics also reads what the acceleration is at t = 0 c. So the total height above the bottom will be = .44 + 13.6 = 14 m c. C.

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