XIII jan MMX

- HW Q & A
- Uniform Circular Motion

(120) $v_0 = 30.0\,m/s$ $\qquad y_{initial} = y_{final}$

$R = 20.0\,m$

find θ_{min} & θ_{max}

$$R = \frac{v_0^2 \sin 2\theta}{|g|} \Rightarrow \sin 2\theta = \frac{R|g|}{v_0^2}$$

$$2\theta = \sin^{-1}\left(\frac{R|g|}{v_0^2}\right)$$

$$\theta = \frac{1}{2}\sin^{-1}\left(\frac{R|g|}{v_0^2}\right)$$

$$= \frac{1}{2}\sin^{-1}\left(\frac{20 \cdot 9.8}{30^2}\right)$$

from the calculator, $\theta = 6.289°$

so, $\theta_{min} = 6.289°$, $\theta_{max} = 90° - \theta_{min} = 83.711°$

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* drawing not to scale

** ignore relativistic effects

$$v_x = \frac{x}{t} \Rightarrow t = \frac{x}{v_x} = \frac{1\,m}{3 \times 10^6} = \underbrace{3.333 \times 10^{-7}\,s}_{333\,ns}$$

on calculator, BE SURE TO USE EE not ×10^

$$y = \cancel{v_{0y} t}^{\,0} + \tfrac{1}{2} a t^2 = -4.9 \left(\frac{1}{3 \times 10^6} \right)^2 = -5.444 \times 10^{-13}\,m$$

or -0.554 pm

$$\boxed{\text{electron drops only } 0.544\,pm}$$

(b) $|y| \to 0$ as $v_x \to \infty$

$v_x \to c$ is really better where c is the speed of light in vacuo

$$y_{v_x = c} = \underbrace{-5.444 \times 10^{-17}\,m}_{\text{smaller than the radius of a proton}} = -54.444\,am$$

or -0.0544 fm

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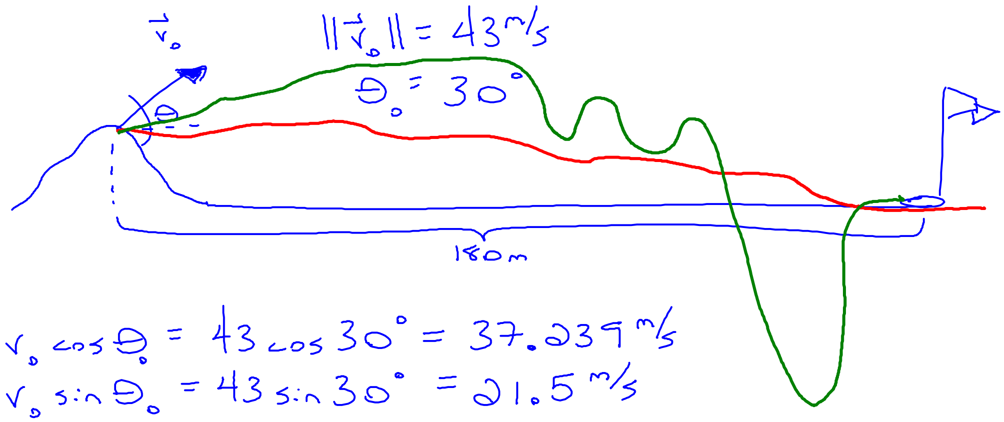


$$v_x = v_0 \cos\theta_0 = 43 \cos 30° = 37.239 \, m/s$$
$$v_{0y} = v_0 \sin\theta_0 = 43 \sin 30° = 21.5 \, m/s$$

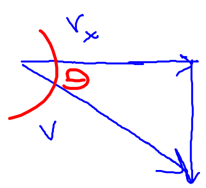
(a) $v_x = \dfrac{x}{t} \Rightarrow t = \dfrac{x}{v_x} = \dfrac{180}{37.239} = 4.834 \, s$

$$y = v_{0y} t + \tfrac{1}{2} a t^2 = (21.5)(4.834) - 4.9(4.834)^2 = -10.570 \, m$$

hill is $\boxed{10.570 \, m}$ "above the hole"

(b) $v_x = 37.239 \, m/s$

$$a = \frac{v_y - v_{0y}}{t} \Rightarrow v_y = at + v_{0y} = (-9.8)(4.834) + 21.5$$
$$= -25.873 \, m/s$$



$$v = (v_x^2 + v_y^2)^{1/2}$$
$$= \left[(37.239)^2 + (-25.873)^2\right]^{1/2} = \boxed{45.345 \, m/s}$$

$$\theta = \tan^{-1}\left|\frac{v_y}{v_x}\right|$$

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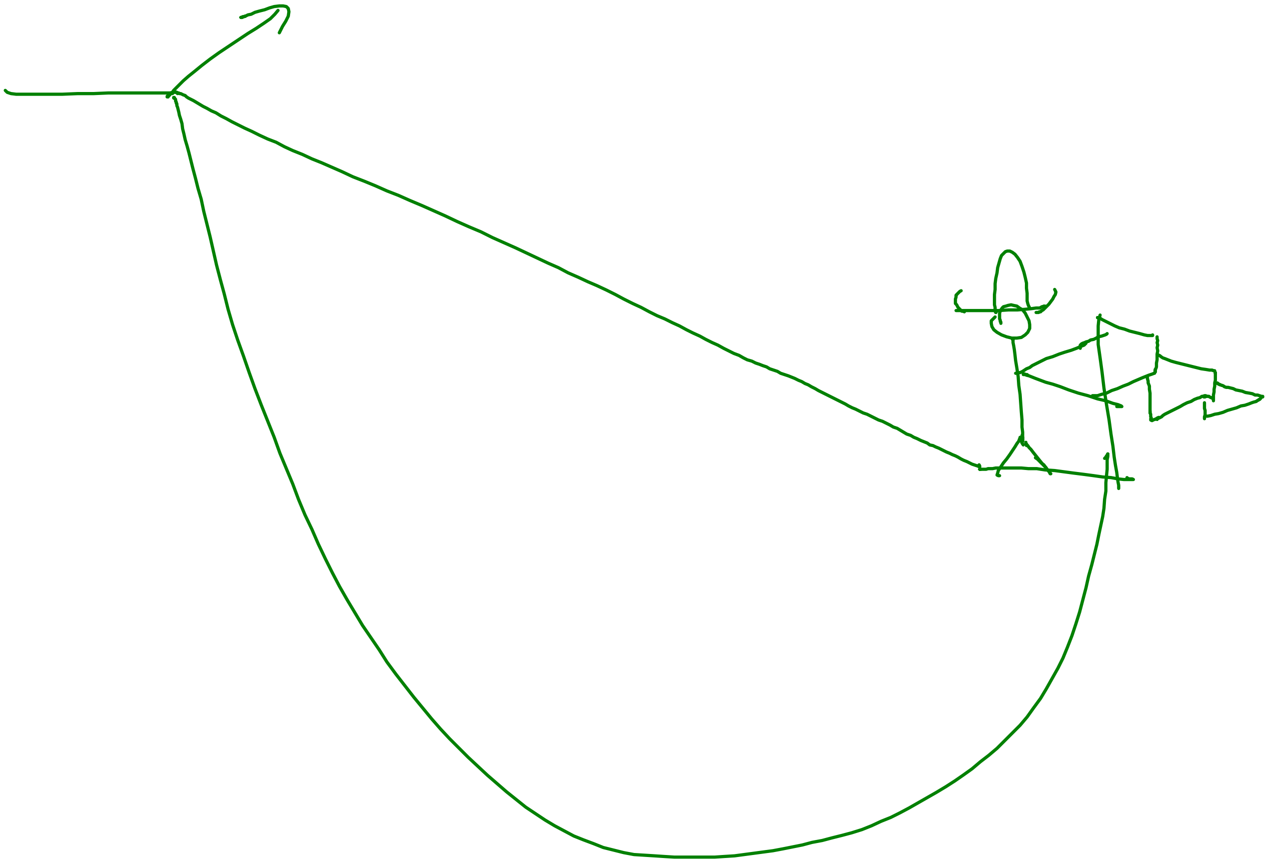
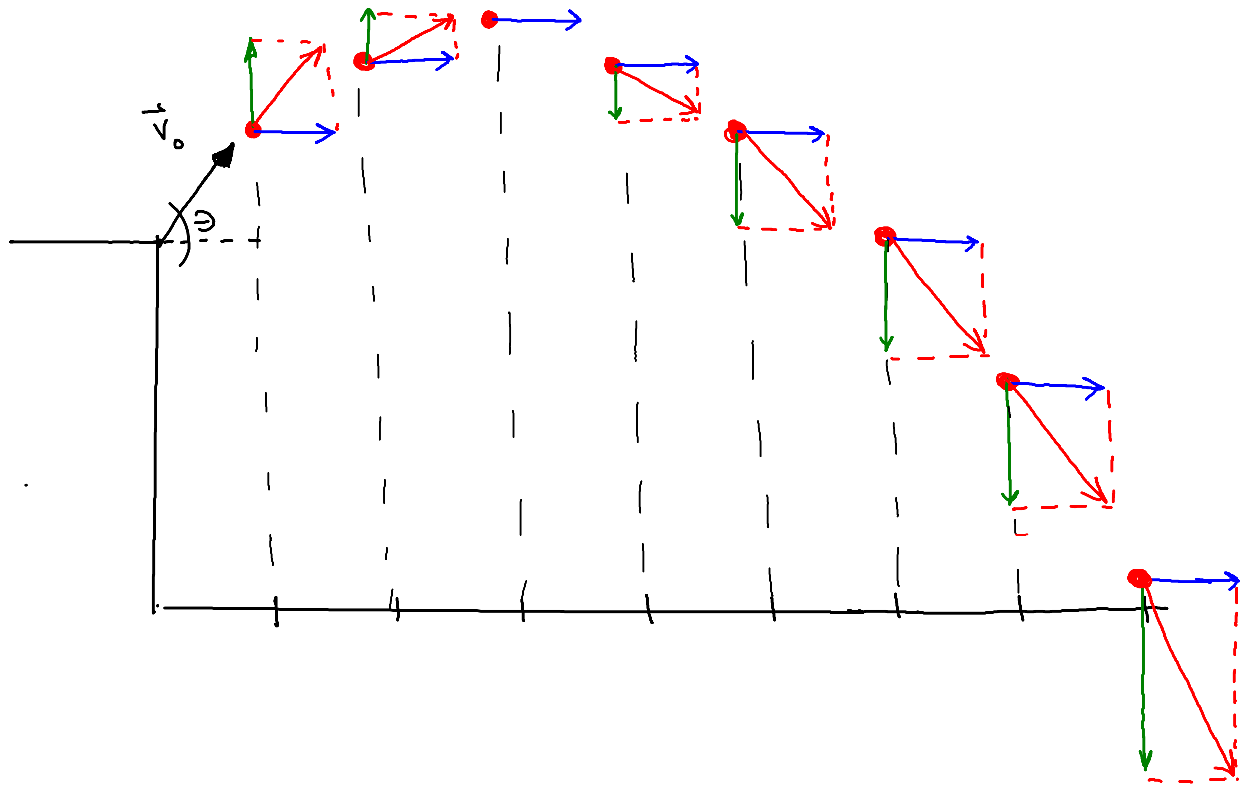


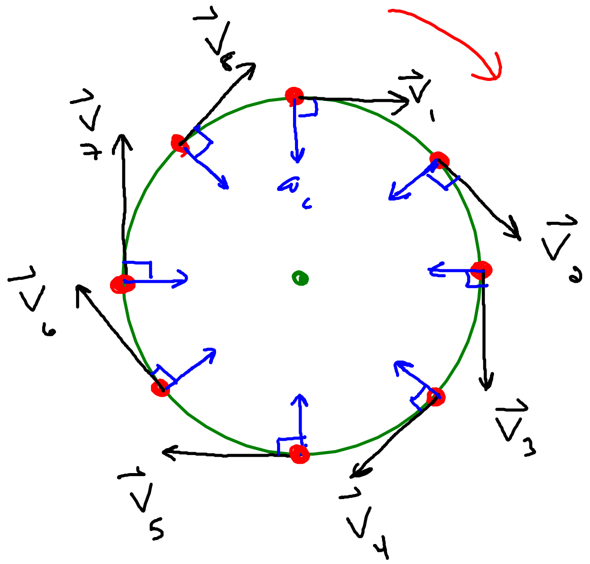
1st Block


v_0
θ

4-7 Uniform Circular Motion

Speed remains CONSTANT

path of motion is exactly a circle



"centripetal"

center pointing

$a_c \equiv$ centripetal acceleration

$$a_c = \frac{v^2}{r}$$

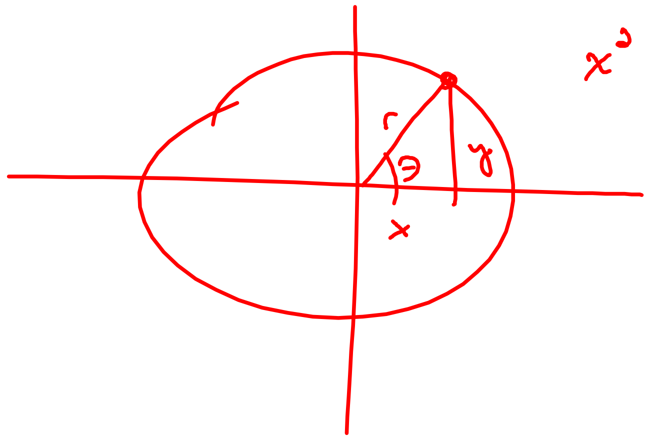
Instructor Notes

III. Circular motion.

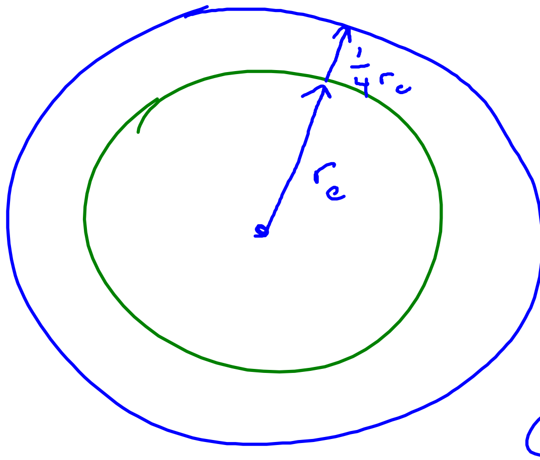
A. Draw the path and describe uniform circular motion, emphasizing that the speed remains constant. Remind students that the acceleration must be perpendicular to the velocity. By drawing the velocity vector at two times, argue that the acceleration vector must be directed inward. On the diagram show the velocity and acceleration vectors for several positions of the particle.

B. Derive $a = v^2/r$. As an alternative to the derivation given in the text, write the equations for the particle coordinates as functions of time, then differentiate twice.

C. Example: calculate the speed of an Earth satellite, given the orbit radius and the acceleration to due to gravity at the orbit. Emphasize that the acceleration is toward Earth.



$x^2 + y^2 = r^2$



$r = \frac{5}{4} r_e$

time for one revolution is 1 day

$C = 2\pi r$

$= 2\pi\left(\frac{5}{4} r_e\right)$

$T = (1 \times 24 \times 60 \times 60)\,s$

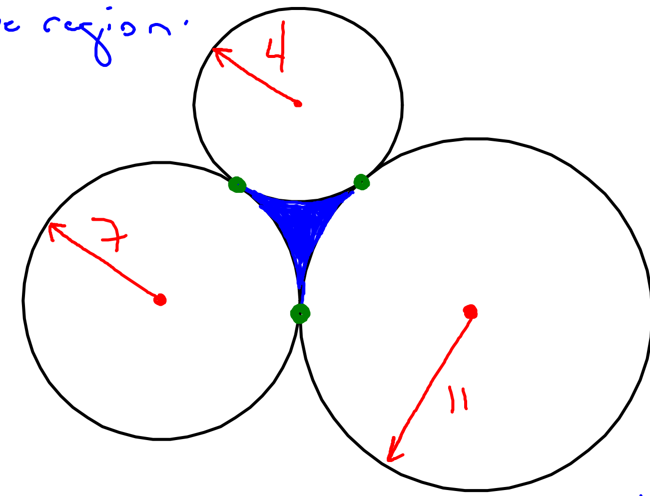
$$\text{speed} = \frac{C}{T} = \frac{2\pi\left(\frac{5}{4} r_e\right)}{1 \times 24 \times 60 \times 60}$$

← meters

← seconds

find the area of the blue region.

Show your work!



+6 on the midterm

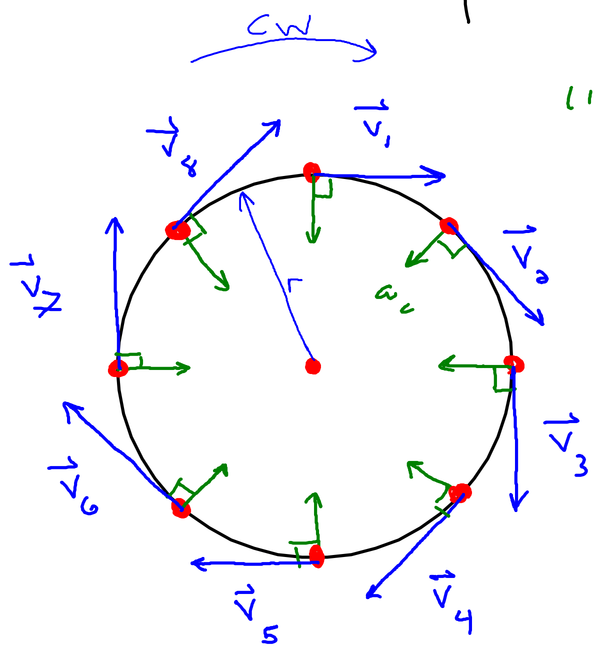
+8 and you solve it like no other student

+11 if you solve correctly in a unique way and you present it on a wall-worthy sign.

Uniform Circular Motion

Uniform → constant speed

Circular → moves along a circular path



"Centripetal"

center pointing

$a_c \equiv$ centripetal acceleration

$$a_c = \frac{v^2}{r} \qquad\qquad a_c = \frac{v^2}{r}$$

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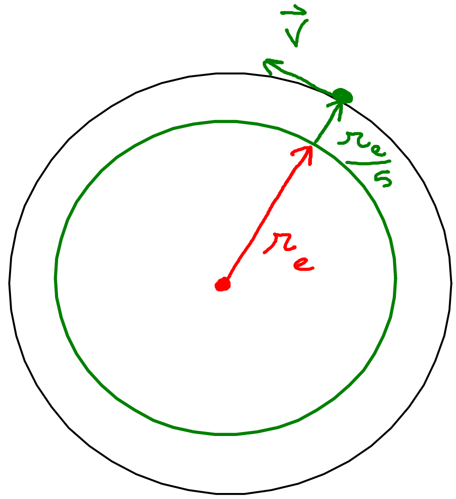
completes 1 revolution in one day at an altitude of $r_e/5$.

Find a_c.



$$a_c = \frac{v^2}{r}$$

$$r = r_e + \frac{r_e}{5}$$
$$= \frac{6}{5} r_e$$

find distance of 1 rev: $C = 2\pi r = 2\pi\left(\frac{6}{5} r_e\right)$
$= 48{,}088{,}987.07\,m$

find time of 1 rev: $1 \times 24 \times 60 \times 60 = 86{,}400\,s$

$v = 556.585\,m/s$

$$a_c = \frac{(556.585\,m/s)^2}{\frac{6}{5} r_e} =$$

HRW

CH 4	58	60	62	63	93
Problems	(44)	(112)	(48)	(49)	(89)