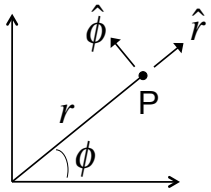
How was the tempo of our last class?

A) Way too fast, I got lost (repeatedly)!
B) Bit fast, but I (mostly) hung in
C) Just about right for me
D) A little slow, I think I could handle a bit more
E) Way too slow, pick it up!

1

Summary of last class: Kinematics
Plane polar coordinates



$$\hat{r} = \cos\phi\ \hat{x} + \sin\phi\ \hat{y}$$

$$\hat{\phi} = -\sin\phi\ \hat{x} + \cos\phi\ \hat{y}$$

$$\vec{r} = r\,\hat{r}$$

$$\vec{v} = d\vec{r}/dt$$

$$\vec{v} = (\dot{r})\hat{r} \quad + \quad r\,\dot{\phi}\hat{\phi}$$

$$\vec{a} = (\ddot{r} - r\dot{\phi}^2)\hat{r} \quad + \quad (r\ddot{\phi} + 2\dot{r}\dot{\phi})\hat{\phi}$$

2

The position of a moving particle is given by

$$\mathbf{r}(t) = b\cos\omega t\ \hat{\mathbf{x}} + b\sin\omega t\ \hat{\mathbf{y}}$$

Describe this orbit:

A) circular, uniform motion
B) circular, non-uniform motion
C) helical
D) elliptical
E) Other!!

Is it moving CW or CCW?

3

The position of a moving particle is given by

$$\mathbf{r}(t) = b\cos\omega t\hat{\mathbf{x}} + c\sin\omega t\hat{\mathbf{y}}$$

Describe this orbit:

A) circular, uniform motion
B) circular, non-uniform motion
C) helical
D) elliptical
E) Other!!

4

In Phys 1110, angular acceleration was $\alpha = a_{tangent}/R$. Which term involves "α"?

$$F_r = \overset{A}{m\ddot{r}} - \overset{B}{mr\dot{\varphi}^2}$$

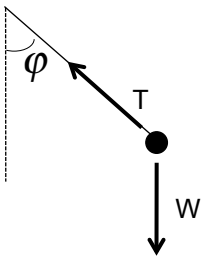
$$F_\varphi = \overset{C}{mr\ddot{\varphi}} + \overset{D}{2m\dot{r}\dot{\varphi}}$$

E) None, or *more* than 1 of these!

What is T_φ?

$$F_r = m\ddot{r} - mr\dot{\varphi}^2$$

$$F_\varphi = mr\ddot{\varphi} + 2m\dot{r}\dot{\varphi}$$

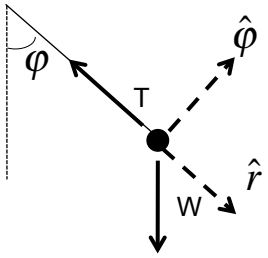


A) T
B) Tcosφ
C) Tsinφ
D) 0
E) Something else (signs!)

$$F_r = m\ddot{r} - mr\dot{\varphi}^2$$

$$F_\varphi = mr\ddot{\varphi} + 2m\dot{r}\dot{\varphi}$$

What is T_φ?



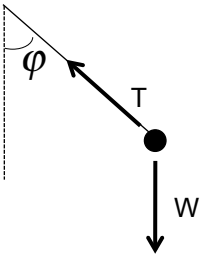
A) T
B) Tcosφ
C) Tsinφ
D) 0
E) Something else (signs!)

7

$$F_r = m\ddot{r} - mr\dot{\varphi}^2$$

$$F_\varphi = mr\ddot{\varphi} + 2m\dot{r}\dot{\varphi}$$

What is W_φ?



A) mg
B) mg cosφ
C) mg sinφ
D) 0
E) Something else (signs!)

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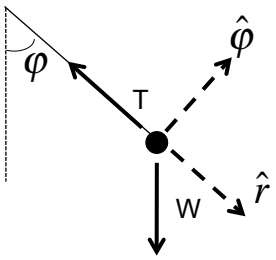
What is W_φ?



$$F_r = m\ddot{r} - mr\dot{\varphi}^2$$

$$F_\varphi = mr\ddot{\varphi} + 2m\dot{r}\dot{\varphi}$$

A) mg
B) mg cosφ
C) mg sinφ
D) 0
E) Something else (signs!)

Classify this ODE:
y" = sin(x) y

A) 1st order, nonlinear
B) 1st order, linear
C) 2nd order, nonlinear
D) 2nd order, linear
E) None of these

Classify this ODE:

$y'' + x^2y + 1 = 0$

A) Linear (not Homogeneous)
B) Homogeneous (not Linear)
C) Linear and Homogeneous
D) Nonlinear and Inhomogeneous

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Classify this ODE:

$y''(t) + ty(t) + 1 = 0$

A) Linear (not Homogeneous)
B) Homogeneous (not Linear)
C) Linear and Homogeneous
D) Nonlinear and Inhomogeneous

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Classify this ODE:

y''(t) = (t+1)y(t)

A) Linear (not Homogeneous)
B) Homogeneous (not Linear)
C) Linear and Homogeneous
D) Nonlinear and Inhomogeneous

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Classify this ODE:

y' = sin(y) +1

A) Linear (not Homogeneous)
B) Homogeneous (not Linear)
C) Linear and Homogeneous
D) Nonlinear and Inhomogeneous

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Is this ODE homogeneous?

y'' = (x+1)y

A) Yes
B) No
C) ???

16

Consider the ODE: $dN/dt - kN = 0$
with $k>0$ and $N(t=0)=N_0>0$.
How does N(t) behave as $t \rightarrow \infty$?

A) N(t) decays to zero
B) N(t) approaches a constant value
C) N(t) stays constant the whole time
D) N(t) diverges (approaches ∞)
E) Not enough info given!

17

Which of these ODEs are separable?

i) $y' = \frac{y^2}{t} - t$ ii) $y' = e^t \frac{y+1}{\sqrt{t}}$

iii) $y' = 3 - t$

A) none
B) i & ii
C) ii & iii
D) i & iii
E) all

18

Classify this ODE:

$$\dot{v} = -g\left(1 - \frac{v^2}{v_{\text{terminal}}^2}\right)$$

A) 1st order, nonlinear
B) 1st order, linear
C) 2nd order, nonlinear
D) 2nd order, linear
E) None of these

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