Rectilinear–Angular Motion

- Wishing Well: linear rope from the bucket gets wrapped around the pulley

–How many turns on the crank equals the distance to the water?

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Converting distance

- Since each radian equals the distance of the radius, we can convert using:

$$s = r\,\theta$$

where s and r are in the same units

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Example of distance

How long is a cable that is wrapped around a 2 ft dia spool 10 times?

$$s = r\theta = \frac{2\,ft}{2} \times \frac{10\,revs}{1} \times \frac{2\pi\,rad}{1\,rev}$$

$$s = 62.8\,ft$$

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Converting velocity

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

$$v = r\omega$$

- Divide distance equation by time
- Linear velocity is the same as angular velocity times the radius

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Example of velocity

- The well crank is rotating at 10 rpm. What is the linear velocity of the bucket?

$$v = r\omega$$

$$v = \frac{2\,ft}{2} \times \frac{10\,rev}{\min} \times \frac{2\pi\ rad}{rev} \times \frac{1\min}{60\sec}$$

$$v = 1.05\,ft/s$$

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Converting Acceleration

$$\frac{v}{t} = r\frac{\omega}{t}$$

$$a = r\alpha$$

- Divide velocity equation by time
- Linear acceleration is the same as angular acceleration times the radius

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Example of Acceleration

- If the bucket falls due to gravity (no friction or inertial forces), what is the acceleration of the crank?

$$a = r\alpha$$

$$32.2\,ft/s^2 = \frac{2\,ft}{2} \times \alpha$$

$$\alpha = 32.2\,rad/s^2$$

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Normal & Tangential Accel.

- A car speeding up around a constant radius turn experiences both types of acceleration.
  - –Increasing speed
  - –Normal (centrifugal) acceleration

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Normal & Tangential

- Refer to normal accel as a_n
  - –Due to changing direction
- Tangential accel = a_t
  - –Due to changing speed
- Usually, tangential acceleration is zero

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Normal Acceleration

- Explained in Chapter 10
- Always points to center of radius
- Change in velocity vectors (v_2-v_1) points toward center

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Calculating Normal Accel.

- Two equations – based on linear tangential velocity or angular velocity

$$a_n = \frac{v^2}{r} \quad or \quad a_n = \omega^2 r$$

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CART Example Again

- Texas Motor Speedway
- 220 mph = 322 ft/s
- Turn radius = 750 ft

$$a_n = \frac{v^2}{r} = \frac{(322\,ft/s)^2}{(750\,ft)}$$

$$a_n = 138\,ft/s^2 \quad or \quad 4.3g's$$

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Week 5 Homework

- Chapter 11
  - –26, 30, 31, 34, 42, 46, 59, 60
- Read Sections 12-1 & 12-2

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