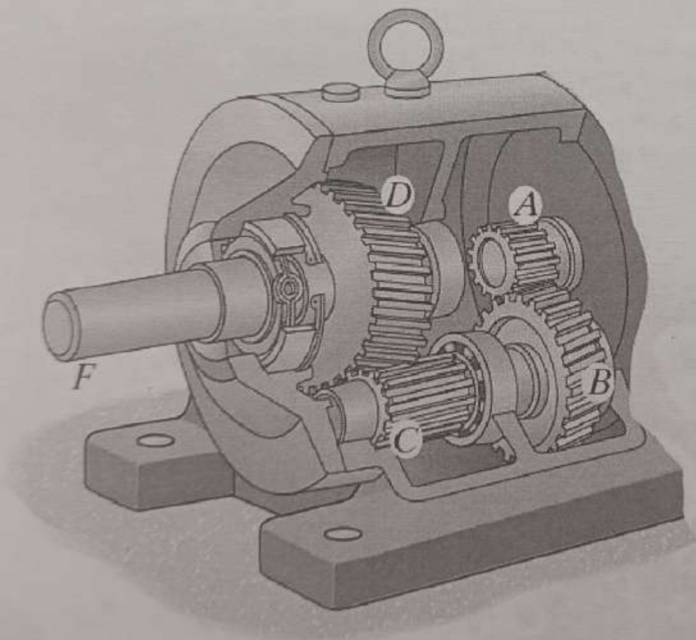
Homework

If gear A rotates with a constant angular acceleration of $\alpha_A = 90\ \text{rad/s}^2$, starting from rest, determine the time required for gear D to attain an angular velocity of 600 rpm. Also, find the number of revolutions of gear D to attain this angular velocity. Gears A, B, C, and D have radii of 15 mm, 50 mm, 25 mm, and 75 mm, respectively.

r_A r_B r_C r_D

t

$$\omega_D = 600\ rpm = \frac{600 \times 2\pi\ rad}{60\ s} = 20\pi\ rad/s$$



解:

$$\alpha_A = 90\ rad/s^2$$

$$\omega_A \cdot r_A = \omega_B \cdot r_B$$

$$\omega_B = \omega_C$$

$$\omega_D \cdot r_D = \omega_C \cdot r_C$$

令 $\omega_D = 20\pi\ rad/s$

$$\Rightarrow \omega_A = 200\pi\ rad/s$$

$$t = \frac{\omega_A}{\alpha_A} = \frac{20\pi}{9} s = 6.98\ s \quad \boxed{ANS}$$

$$r_A \cdot \alpha_A = \alpha_B \cdot r_B$$

$$\alpha_B = \alpha_C$$

$$r_C \cdot \alpha_C = r_D \cdot \alpha_D$$

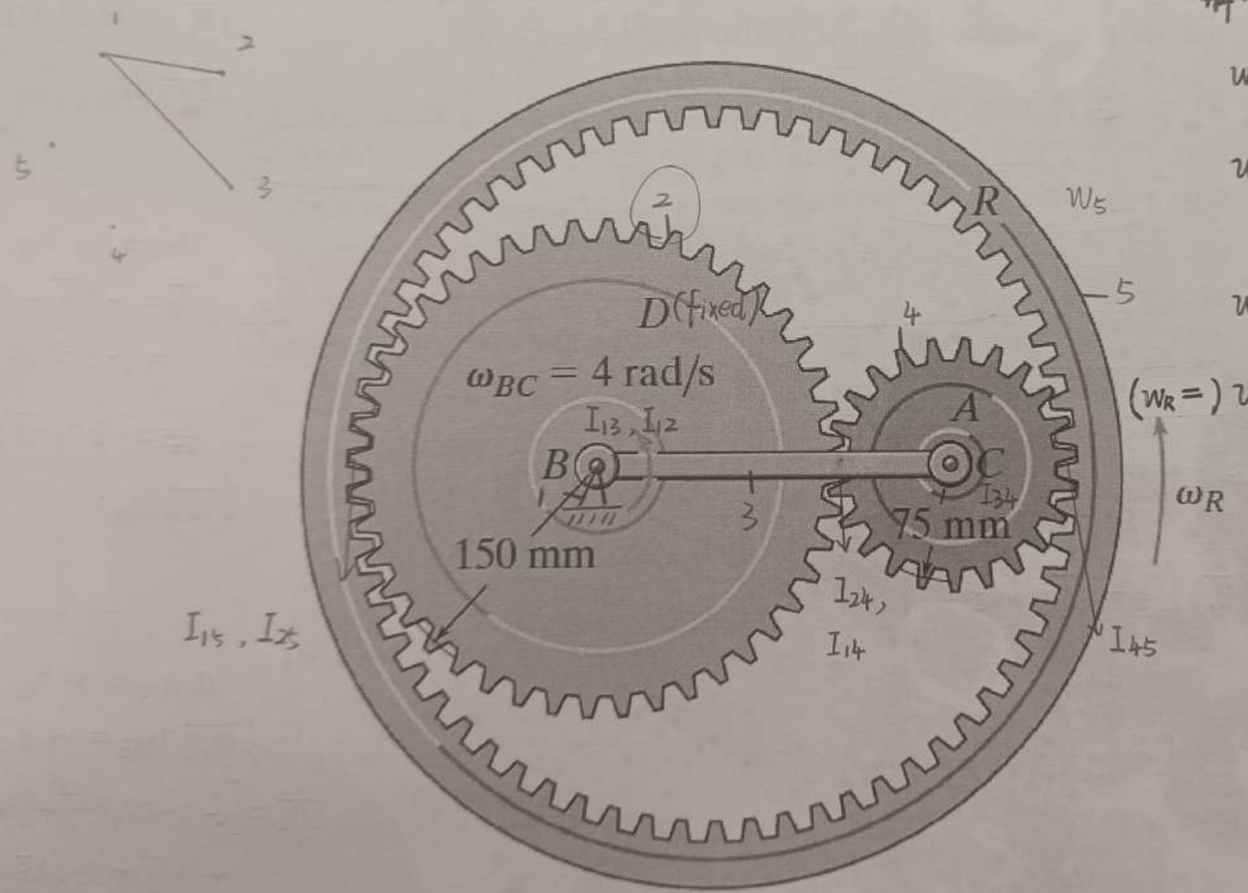
$$\Rightarrow \alpha_D = 9\ rad/s^2$$

$$\theta_D = \frac{1}{2}\alpha_D \cdot t^2 = \frac{200}{9}\pi^2\ rad$$

$$rev = \frac{\theta_D}{2\pi} = \frac{100\pi}{9}\ rev = 34.9\ rev \quad \boxed{ANS}$$

Homework

The planet gear A is pin connected to the end of the link BC. If the link rotates about the fixed point B at 4 rad/s, determine the angular velocity of the ring gear R. The sun gear D is fixed from rotating.



解:

$$\omega_3 I_{13} I_{34} = \omega_4 I_{14} I_{34}$$

$$\omega_4 = \frac{I_{13} I_{34}}{I_{14} I_{34}} \omega_3 = \frac{150+75}{75} \times 4 = 12 \text{ rad/s}$$

$$\omega_4 I_{14} I_{45} = \omega_5 I_{15} I_{45}$$

$$(\omega_R =)\ \omega_5 = \frac{I_{14} I_{45}}{I_{15} I_{45}} \omega_4 = \frac{2\times 75}{2\times 150 + 2\times 75} \times 12 = 4 \text{ rad/s}$$

$\boxed{\text{ANS}}$

Homework

①解:

$\vec{V_C} = \vec{V_B} + (\vec{V_{C/B}})_{xyz} + \vec{\Omega}\times\vec{r_{C/B}}$

$\vec{V_B}$: 20ft/s

$\vec{V_B} = -10\vec{i} + 10\sqrt{3}\vec{j}$

$(\vec{V_{C/B}})_{xyz} = -1\vec{i}$ $\quad V_{C/B} = 1$ ft/s

$\vec{\Omega} = 2\vec{k}$

$\vec{r_{C/B}} = -2\vec{j}$

$\vec{V_C} = (-10\vec{i} + 10\sqrt{3}\vec{j}) + (-1)\vec{i} + (-4)(-\vec{i})$

$= -7\vec{i} + 10\sqrt{3}\vec{j} = -7\vec{i} + 17.32\vec{j}$

$|\vec{V_C}| = \sqrt{7^2 + (10\sqrt{3})^2} = 18.68$ ft/s $\quad \theta = 67.99^\circ$ $\boxed{\text{ANS}}$

$\vec{a_C} = \vec{a_B} + \dot{\vec{\Omega}}\times\vec{r_{C/B}} + \vec{\Omega}\times(\vec{\Omega}\times\vec{r_{C/B}}) + 2\vec{\Omega}\times(\vec{V_{C/B}})_{xyz} + (\vec{a_{C/B}})_{xyz}$

$\vec{a_B}$: a_{tB}, a_{nB}

$a_{tB} = 0$, $a_{nB} = \omega_{AB}^2\cdot r_{AB} = 40$ ft/s²

$\vec{a_B} = -20\sqrt{3}\vec{i} + (-20)\vec{j}$

$(\vec{a_{C/B}})_{xyz}$: a_{cn}, a_{ct}

$a_{ct} = 0$, $a_{cn} = \omega'^2\cdot r_{BC} = 0.5$ ft/s², $(\vec{a_{C/B}})_{xyz} = 0.5\vec{j}$

$\vec{a_C} = -20\sqrt{3}\vec{i} + (-20)\vec{j} + 0 + \underbrace{(2\vec{k})\times(4\vec{i})}_{8\vec{j}} + \underbrace{4\vec{k}\times(-1)\vec{i}}_{(-4)\vec{j}} + 0.5\vec{j} = -20\sqrt{3}\vec{i} + (-15.5)\vec{j}$

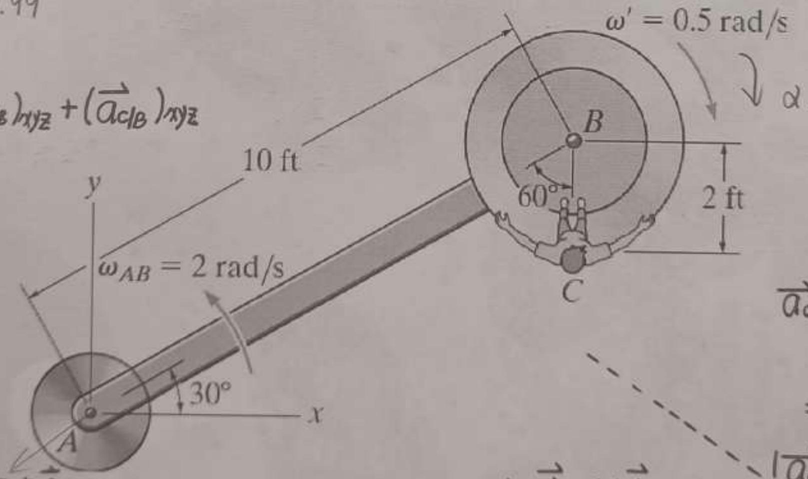
$= -34.64\vec{i} - 15.5\vec{j}$

$\theta = 24.11^\circ$

$|\vec{a_C}| = 37.95$ ft/s² $\boxed{\text{ANS}}$

① A ride in an amusement park consists of a rotating arm AB having a constant angular velocity $\boxed{\omega_{AB} = 2\text{ rad/s}}$ point A and a car mounted at the end of the arm which has a constant angular velocity $\omega' = \{-0.5\mathbf{k}\}$ rad/s, measured relative to the arm. At the instant shown, determine the velocity and acceleration of the passenger at C.

② A ride in an amusement park consists of a rotating arm AB that has an angular acceleration of $\alpha_{AB} = 1$ rad/s² when $\omega_{AB} = 2$ rad/s at the instant shown. Also at this instant the car mounted ~~at the end~~ of the arm has an angular acceleration of $\alpha = \{-0.6\mathbf{k}\}$ rad/s² and angular velocity of $\omega' = \{-0.5\mathbf{k}\}$ rad/s, measured relative to the arm. Determine the velocity and acceleration of the passenger C at this instant.



②解:

$\vec{V_C} = \vec{V_B} + (\vec{V_{C/B}})_{xyz} + \vec{\Omega}\times\vec{r_{C/B}}$

it is same with ①

$\vec{V_C} = -7\vec{i} + 17.32\vec{j}$

$|\vec{V_C}| = 18.68$ ft/s, $\theta = 67.99^\circ$ $\boxed{\text{ANS}}$

$\vec{a_B}$: $a_{t.B}$, $a_{n.B}$

$a_{t.B} = r_{AB}\cdot\alpha_{AB} = 10$ ft/s², $a_{n.B} = 40$ ft/s²

$\vec{a_B} = -5\vec{i} + 5\sqrt{3}\vec{j} - 20\sqrt{3}\vec{i} - 20\vec{j}$

$= (-5-20\sqrt{3})\vec{i} + (5\sqrt{3}-20)\vec{j}$

$\dot{\vec{\Omega}} = \alpha_{AB}\vec{k} = 1\vec{k}$

$(\vec{a_{C/B}})_{xyz}$: $a_{C/B.n}$, $a_{C/B.t}$

$a_{C/B.t} = \alpha\cdot r_{C/B} = 1.2$ ft/s², $a_{C/B.n} = 0.5$ ft/s²

$(\vec{a_{C/B}})_{xyz} = -1.2\vec{i} + 0.5\vec{j}$ $\quad (1.2)\vec{i}$

$\vec{a_C} = [(-5-20\sqrt{3})\vec{i} + (5\sqrt{3}-20)\vec{j}] + \vec{k}\times(-2\vec{j}) + 8\vec{j} + (-4)\vec{j} + (-1.2\vec{i} + 0.5\vec{j})$

$= (-4.2-20\sqrt{3})\vec{i} + (5\sqrt{3}-15.5)\vec{j} = -38.84\vec{i} - 6.84\vec{j}$

$|\vec{a_C}| = 39.44$ ft/s² $\quad \theta = 9.99^\circ$ $\boxed{\text{ANS}}$