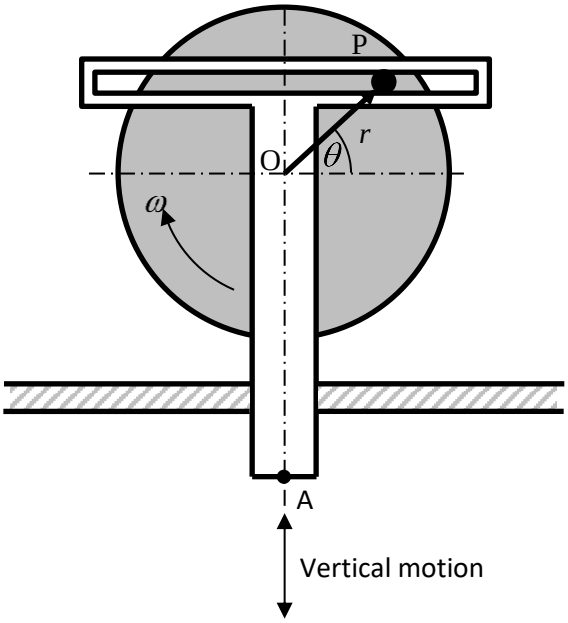
Department of Mechanical, Materials and Manufacturing Engineering

University of Nottingham

MACHINE DYNAMICS

SHEET 3: KINEMATICS OF LINKAGE MECHANISMS

1. The figure below shows a slotted link (Scotch Yoke) mechanism used to convert rotational motion into vertical translational motion – this is an example of a reciprocating motion mechanism. The mechanism consists of a circular disc and a sliding yoke with a slot. The disc rotates about a fixed centre through O and has a pin (P) rigidly attached to it at distance r from the centre of the disc. As the disc rotates, contact between the pin and the slot causes the yoke to move vertically as shown.

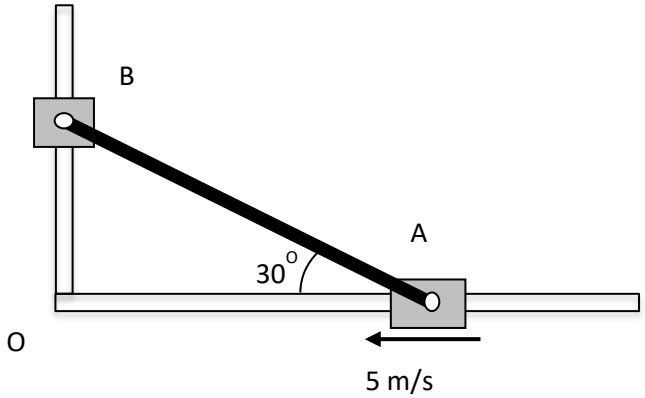


The pin is located at a radius $r = 2\,\text{cm}$ and the wheel has constant angular velocity $\omega = 6\,\text{rad/s}$, and at the instant shown $\theta = 30^\circ$.

Calculate the magnitude and direction of the velocity and acceleration of point A.

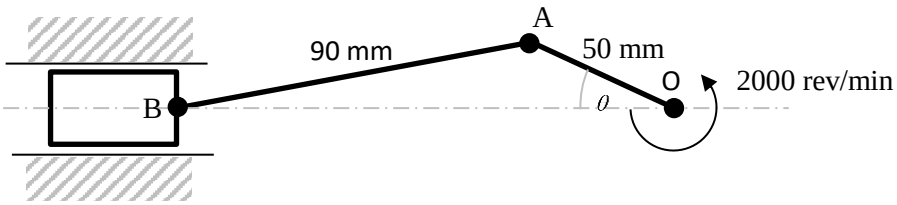
[0.104m/s downwards; 0.36m/s^2 downwards]

2. The ends A and B of a rigid link (*AB*=0.5 m) move along fixed horizontal and vertical guides. In the position shown, A is moving towards O with a constant velocity of 5 m/s. Calculate the velocity and acceleration of B and the angular velocity and angular acceleration of AB.



[8.660 m/s; 400 m/s^2; 20 rad/s (CW); 692.8 rad/s^2 (ACW)]

3. The figure shows a slider-crank mechanism consisting of a $50\,\text{mm}$ radius crank (OA) which rotates at $2000\,\text{rev/min}$, and a connecting rod (AB) having length $90\,\text{mm}$.

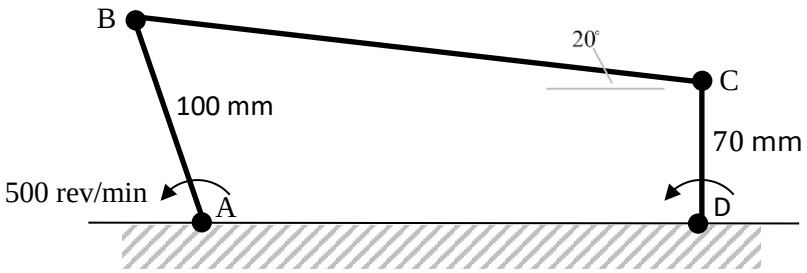


At the instant shown, angle $\theta = 30^\circ$.

Calculate the magnitude and direction of the velocity of piston B relative to crank centre O, and the angular velocity of connecting rod AB.

[7.86 m/s, right to left; 104.9 rad/s (CW)]

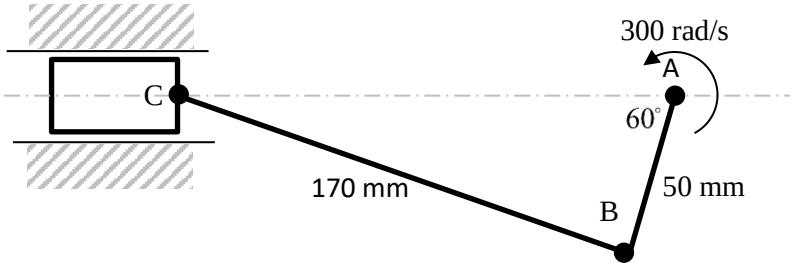
4. The figure shows a 4 bar chain ABCD consisting of input crank AB having length $100\,\text{mm}$ and output crank DC having length 70 mm. At the instant shown, the input crank has angular velocity $500\,\text{rev/min}$ and orientation 60°, the connecting rod has orientation 20°, and the output crank is vertical.



Calculate the angular velocity of the output crank.

[489 rev/min]

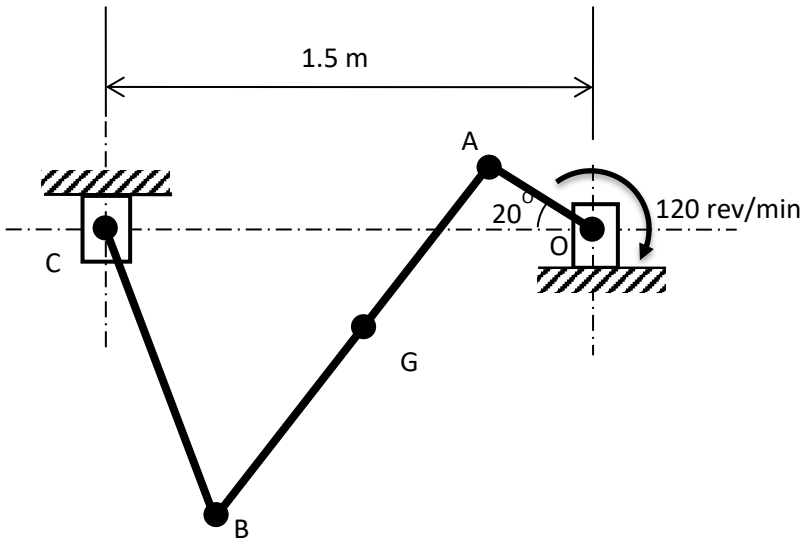
5. A piston, connecting rod and crank mechanism is shown in the below figure. The crank rotates at a constant angular velocity of $300\,\text{rad/s}$.



At the instant shown, calculate the magnitude and direction of the acceleration of piston C and the angular acceleration of connecting rod BC.

[1589 m/ s^2, left to right, 23158 rad/s^2 (ACW)]

6. In the four-bar linkage OABC shown, crank OA is driven clockwise at a constant speed of 120 rev/min. The centre of mass for link AB is located at G, the midpoint of link AB. In the position shown, determine the linear acceleration of G and the angular acceleration of AB. The link lengths are as follows: *OA*=0.5m, *AB*=1.5m, *BC*=1m.



[52.44 m/s^2; 71.61 rad/s^2 (CW)]