

# Solid Mechanics 2 Tutorial Sheets

Tutorial Sheets and Answers for DE2's Enjoyment

## Tutorial Sheet 1: Planar Kinematics

### Topics covered are:

- Types of motion
- Rotation around a fixed axis
- Relative velocity
- Instantaneous centres

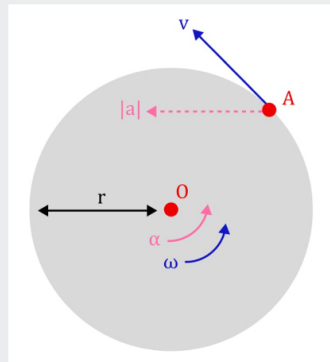
### Tips

- Always draw the situation!
- The order of the cross product matters,  $\omega \times r \neq r \times \omega$

### Question 1

At the instant shown, the disk has angular velocity is 2 rad/s counter clockwise and angular acceleration 6 rad/s<sup>2</sup>. Its radius is 0.2 m.

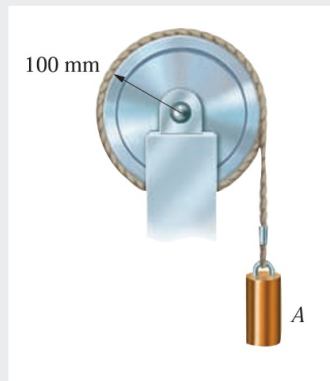
What are the magnitudes of the velocity and acceleration of point A?



### Question 2

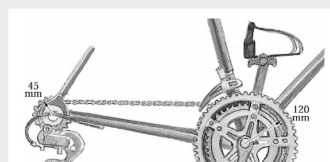
The mass  $A$  starts from rest at  $t=0$  and falls with a constant acceleration of 8 m/s<sup>2</sup>. When the mass has fallen one meter, determine the magnitudes of:

- The angular velocity of the pulley.
- The tangential and normal components of acceleration of a point at the outer edge of the pulley.



### Question 3

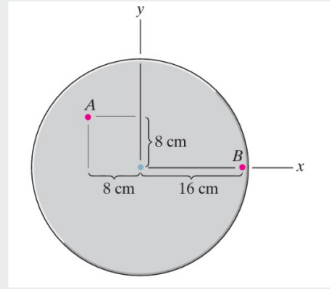
- If the bicycle's 120 mm radius sprocket wheel rotates through one revolution, through how many revolutions does the 45 mm gear turn?
- If the angular velocity of the sprocket wheel is 1 rad/s, what is the angular velocity of the gear?





#### Question 4

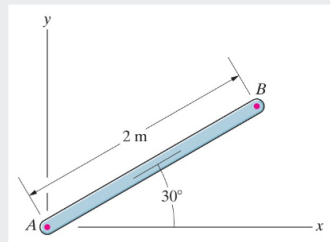
The disk is rotating about the origin with a constant clockwise angular velocity of 100 rpm. Determine the  $x$  and  $y$  components of velocity of points  $A$  and  $B$  (in cm/s).



#### Question 5

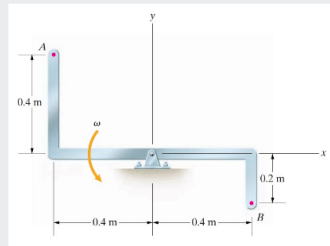
The bar is moving in the  $x$ - $y$  plane and is rotating in the counterclockwise direction. The magnitude of the velocity of point  $A$  relative to point  $B$  is 8 m/s. Relative to a nonrotating reference frame with origin  $A$ , what is the

- (a) Angular velocity of the bar.
- (b) Velocity of  $B$  relative to the reference frame in vector form.



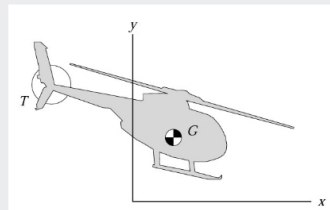
#### Question 6

The bar is rotating in the counterclockwise direction with angular velocity  $\omega$ . The magnitude of the velocity of point  $A$  relative to point  $B$  is 6 m/s. Determine the velocity of point  $B$  (relative to the origin).



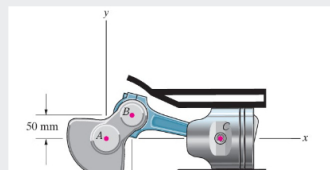
#### Question 7

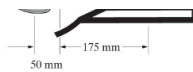
The helicopter is in planar motion in the  $x$ - $y$  plane. At the instant shown, the position of its center of mass,  $G$ , is  $x=2\text{m}$ ,  $y=2.5\text{m}$ , and its velocity is  $\mathbf{v}_G = 12\mathbf{i} + 4\mathbf{j}$  (m/s). The position of point  $T$ , where the tail rotor is mounted, is  $x=-3.5\text{m}$ ,  $y=4.5\text{m}$ . The helicopter's angular velocity is 0.2 rad/s clockwise. What is the velocity of point  $T$ ?



#### Question 8

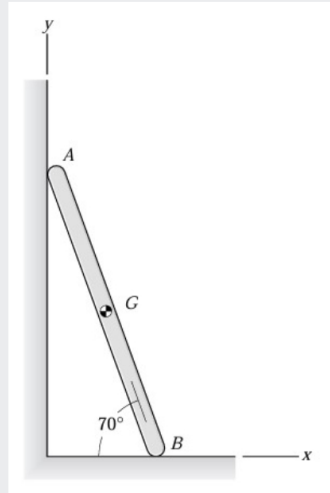
At the instant shown, the piston's velocity is  $\mathbf{v}_C = -14\mathbf{i}$  m/s. What is the angular velocity of the crank  $AB$ , which rotates around  $A$ ?





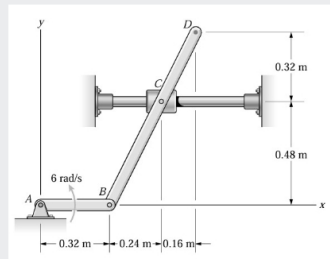
### Question 9

Points A and B of the 2 m bar slide on the plane surfaces. Point B is moving to the right at 3 m/s. What is the velocity of the midpoint G of the bar?



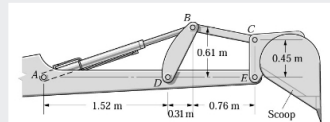
### Question 10

Bar AB rotates in the counterclockwise direction at 6 rad/s. Determine the angular velocity of bar BD and the velocity of point D.



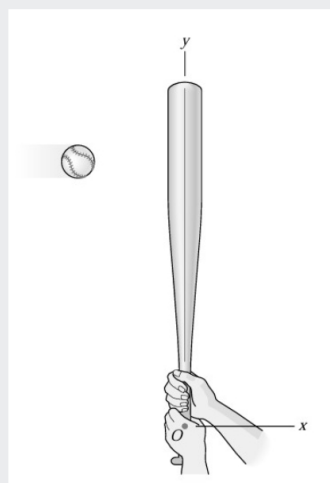
### Question 11

The horizontal member ADE supporting the scoop is stationary. If the link BD is rotating in the clockwise direction at 1 rad/s, what is the angular velocity of the scoop?



### Question 12

The velocity of point O of the bat is  $v_O = -1.83i - 4.27j$  m/s, and the bat rotates about the z axis with a counterclockwise angular velocity of 4 rad/s. What are the x and y coordinates of the bat's instantaneous center?



### Question 13

Points A and B of the 1m bar slide on the plane surfaces. The velocity of B is  $v_B = 21$  m/s.

- (a) What are the coordinates of the instantaneous center of the bar?
- (b) Use the instantaneous center to determine the velocity at A.

