Continuing Education Course #295
Review of Engineering Dynamics
Part 1: Kinematics of Particles and Rigid Bodies

1. Which of the following is an example of a scalar quantity?
- a. Kinetic energy
- b. Force
- c. Acceleration
- d. Momentum

2. Energy stored in a stretched spring is known as
- a. Kinetic energy
- b. Gravitational potential energy
- c. Elastic potential energy
- d. None of the above

3. Two objects, one twice as heavy as the other, are dropped to the ground from the roof of a building. Just before hitting the ground, the heavier object has
- a. the same kinetic energy as the lighter one
- b. half as much kinetic energy as the lighter one
- c. twice as much kinetic energy as the lighter one
- d. four times as much kinetic energy as the lighter one

4. A dynamics problem statement is given as follows: *A 20 kg cart rests on a flat horizontal track. A constant force of 10 N is applied to the cart causing motion in the positive x direction. Determine the velocity of the cart after 7 seconds.* Which of the following categories best describes the problem statement?
- a. Particle kinematics
- b. Particle kinetics
- c. Rigid body kinematics
- d. Rigid body kinetics

5. A particle moves along a straight line. Its position is defined by the expression $s = 5t^2$, where t is expressed in seconds and s is in meters. What is the acceleration of the particle in meters per second squared?
- a. 25
- b. 20
- c. 15
- d. 10

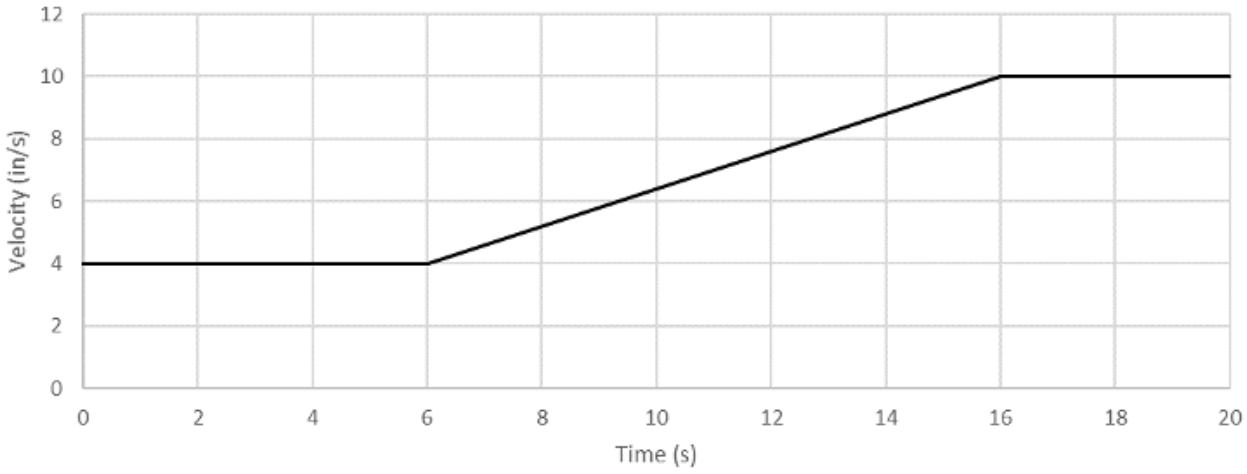
6. The velocity of a particle in rectilinear motion is defined by the equation $v(t) = 2t^4 + 5$ and has the units of feet per second. What is the particle's acceleration, in feet per second squared, at a time of 1 second?
- a. 13
- b. 7

○ c. 2
○ d. 8

7. An object is released from rest and it slides down an inclined plane. It has a speed of 0.7 m/s after 2 seconds. Approximately how far does it travel in 6 seconds?

○ a. 3.4 m
○ b. 4.1 m
○ c. 5.7 m
○ d. 6.3 m

8. The graph below shows the velocity of a particle moving along a straight line. What is the acceleration (in/s²) of the particle at a time of 10 seconds?

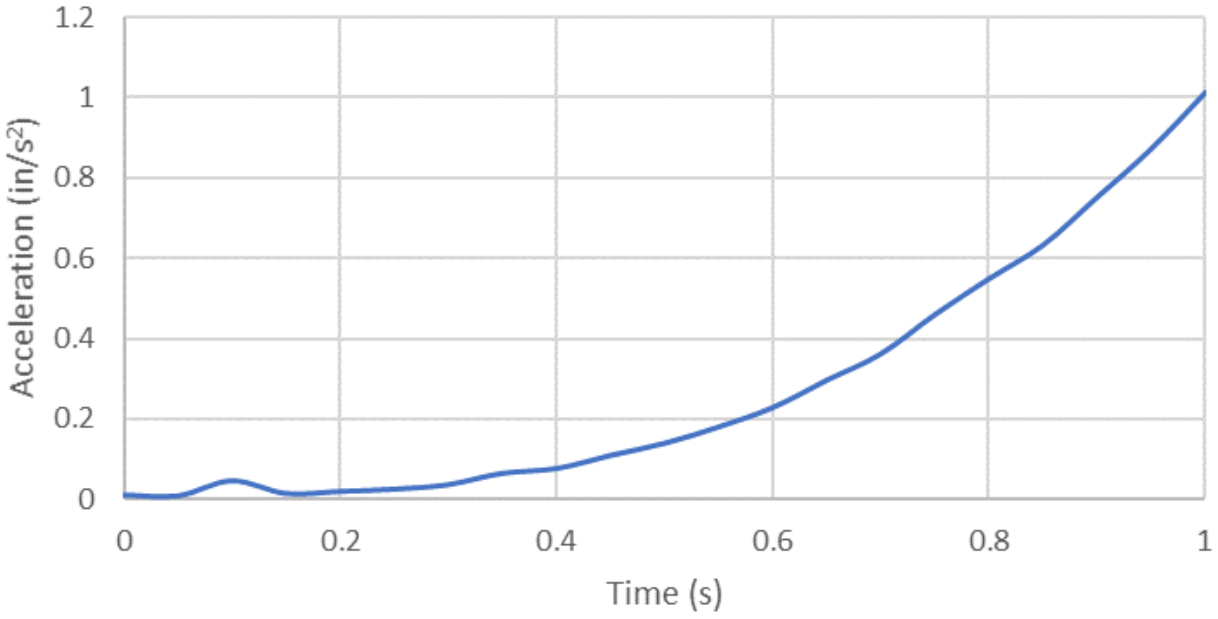


○ a. 0.3
○ b. 0.6
○ c. 1.2
○ d. None of the above

9. A 10kg ball is dropped from a height h and strikes the ground at a velocity of 24 m/s. What is the height h in meters?

○ a. 20.2
○ b. 29.4
○ c. 35.6
○ d. 48.7

10. A particle moving along a straight line starts from rest. The acceleration for the first second is measured and shown on the graph below. Which of the following would give the best approximate velocity (in/s) of the particle at 1 second?



- a. 0
- b. 0.3
- c. 1.1
- d. 2.7

11. The position of a particle is defined by $\vec{r} = (5t^4)\hat{i} + (t^3)\hat{j}$ where time is in seconds. What is the magnitude of acceleration along the x-axis at a time of 1 second?

- a. 60
- b. 30
- c. 20
- d. 5

12. A particle moves in curvilinear motion. Its y-coordinate is defined by $y = 98 - 2t^2$, where y is in feet and t is in seconds. The velocity of the particle in the x-coordinate direction is defined by $v_x = 30 - 6t$ and has units of feet per second. Knowing that the particle's x-coordinate value is zero at a time of zero, what is the x-coordinate position of the particle (in feet) when the y-coordinate position is equal to zero?

- a. -12
- b. 0
- c. 63
- d. 94

13. A particle travels around a circular path at a constant velocity. The radius of the circular path is 250 meters. What is the particle's velocity (in m/s) if the magnitude of total acceleration is 10 m/s²?

- a. 20
- b. 35
- c. 50
- d. 75

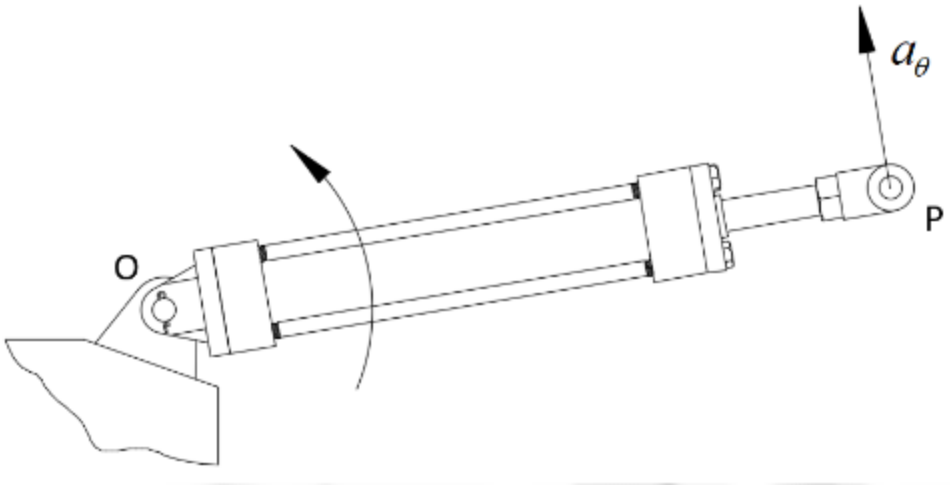
14. A particle moves along a circular path. At a given instant, the velocity of the particle is 28 m/s and it is accelerating at a rate of 0.23 m/s². Knowing the total acceleration magnitude is 0.52 m/s², what is the approximate radius of the circular path in meters?

○ a. 3540
○ b. 2910
○ c. 2160
○ d. 1680

15. Which of the following statements is true about curvilinear motion of a particle?
○ a. Normal acceleration is equal to zero if the particle moves with a constant velocity
○ b. In projectile motion, both the horizontal and vertical motion are defined as uniformly accelerated motion
○ c. Velocity of the particle will be tangent to the path of motion in the direction of motion
○ d. None of the statements are true

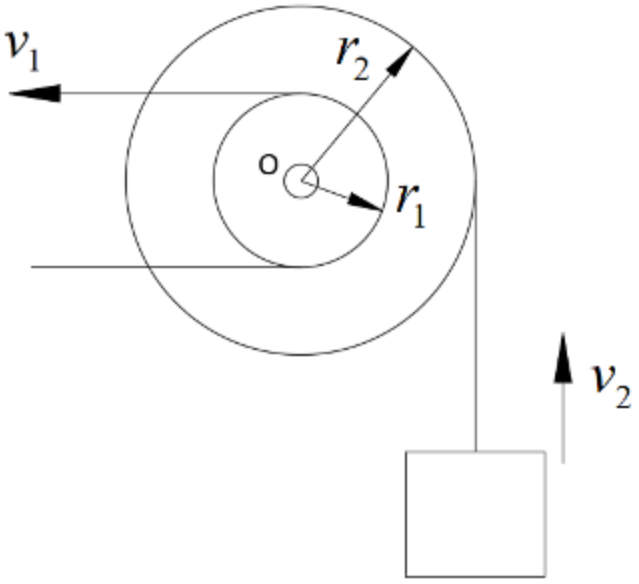
16. Unit vectors $\hat{e}_r$ and $\hat{e}_\theta$ are commonly used in which of the following coordinate systems?
○ a. Rectangular coordinates
○ b. Normal and tangential coordinates
○ c. Polar coordinates
○ d. None of the above

17. The hydraulic cylinder shown rotates counterclockwise at a constant rate of 5 radians per second about the fixed-point O. The rod extends at a fixed rate of 2 inches per second. What is the magnitude of a_θ in inches per second squared?



○ a. 20
○ b. 15
○ c. 10
○ d. 5

18. A drum is driven by a belt drive as shown. The belt velocity is defined as $v1$. The belt turns the pulley with radius $r1$. The pulley is connected to a drum of radius $r2$, and both the pulley and drum rotate about the fixed axis O at the same rotational speed. The drum has a cable that lifts the box shown. Which of the following statements is true about the velocity of the box if $r2 = 3r1$?

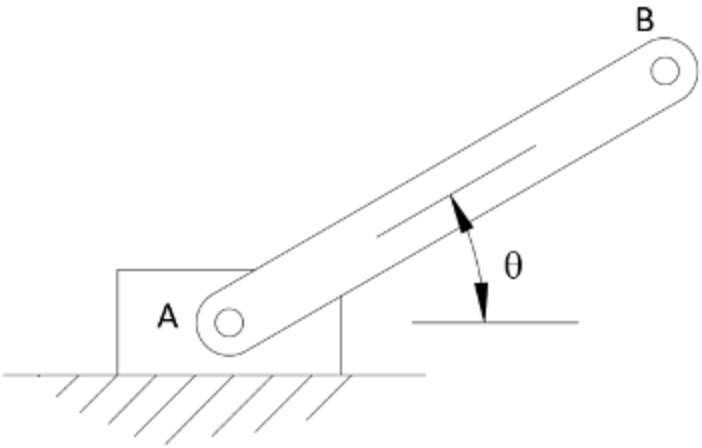


- a. $v2 = 3v1$
- b. $v2 = 6v1$
- c. $v2 = \frac{1}{3}v1$
- d. $v2 = \frac{1}{6}v1$

19. General plane motion is planar motion of a rigid body that is a combination of translation and pure rotation.

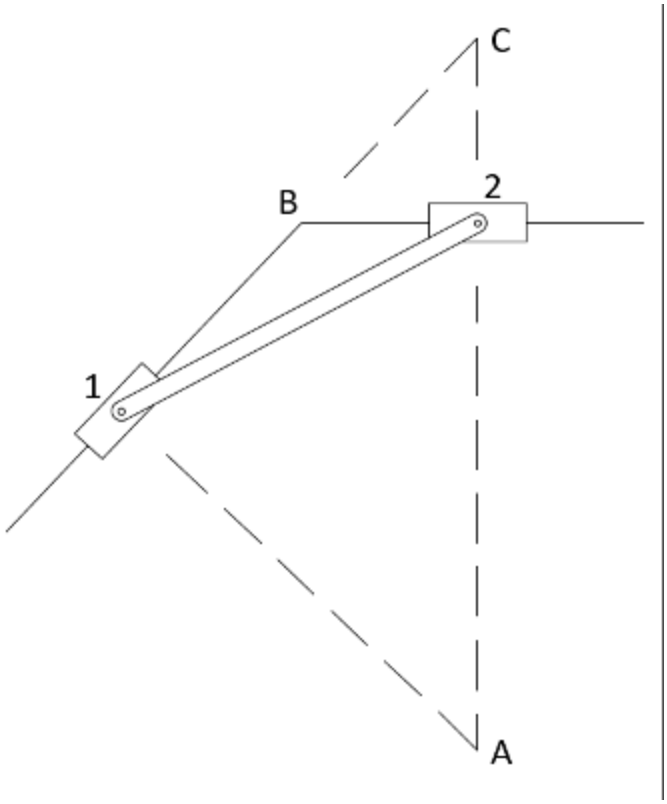
- a. True
- b. False

20. Block A in the figure moves at a constant speed of 0.2 m/s to the right. Link AB is 0.5 meters long and rotates at a constant rate of 2 rad/s counterclockwise. What is the absolute velocity of point B when $\theta = 30°$?



- a. $\vec{v}_B = 0.7\hat{i} - 0.866\hat{j}$
- b. $\vec{v}_B = -0.667\hat{i} + 0.5\hat{j}$
- c. $\vec{v}_B = 1.067\hat{i} - 0.5\hat{j}$
- d. $\vec{v}_B = -0.3\hat{i} + 0.866\hat{j}$

21. Sliders 1 and 2 are constrained to move along the solid lines shown. At the instant shown, the instant center of rotation for link 1-2 is located at which point?

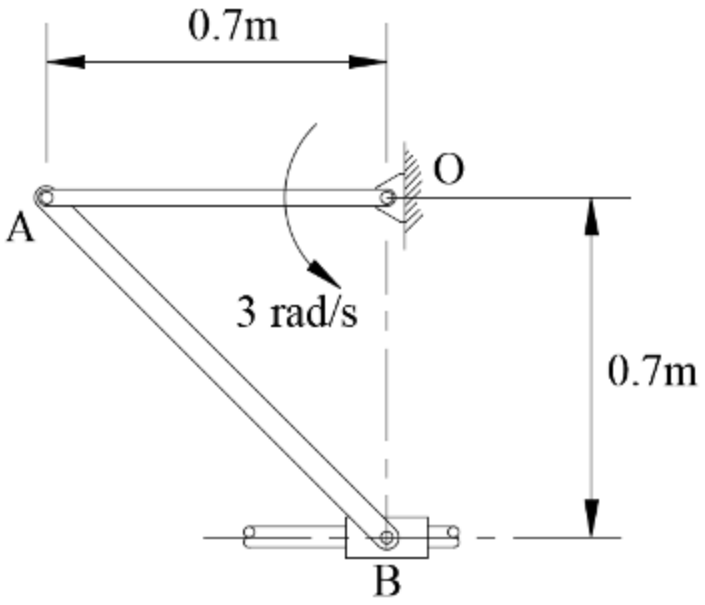


- a. Point A
- b. Point B
- c. Point C
- d. There is no instant center for the position shown

22. The acceleration at the instant center of rotation is always equal to zero.

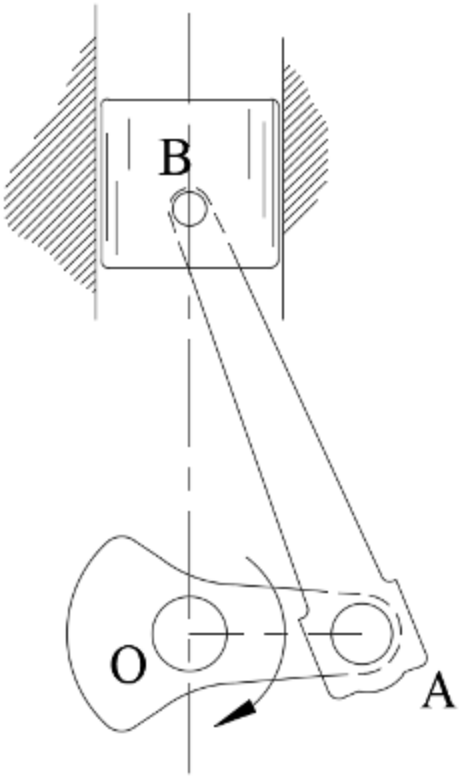
- a. True
- b. False

23. What is the magnitude of the velocity of point B in meters per second?



- a. 1.3
- b. 2.1
- c. 3.9
- d. 4.5

24. Consider the slider crank mechanism shown. For the instant shown when the crank is horizontal, which of the following statements is true?



- a. The velocity of slider B is pointed upwards
- b. The connecting rod AB is in pure translation
- c. The instant center of rotation for connecting rod AB is located at point O
- d. None of the statements are true

25. A location of point P on a rotating body is defined by the position vector $\overrightarrow{r} = 1.3\hat{i} + 0.7\hat{j}$, where the units are in meters. The body rotates counterclockwise at a constant speed of 2 radians per second. Using the equation $\overrightarrow{a}_n = \overrightarrow{\omega} \times \left(\overrightarrow{\omega} \times \overrightarrow{r}\right)$, determine the normal acceleration vector for point P in meters per second squared.

- a. $-2.8\hat{i} - 5.2\hat{j}$
- b. $-2.8\hat{i} + 5.2\hat{j}$
- c. $-5.2\hat{i} - 2.8\hat{j}$
- d. $-5.2\hat{i} + 2.8\hat{j}$