Motion In a Circle - Problem Set

Exercises

Kinematics of Uniform Circular Motion

E1. What is $\frac{\pi}{4} rad$ in degrees? [45°]

$\frac{\pi/4}{2\pi} \times 360°$

E2. What is 300° in radians? [5.23 rad]

$\frac{5}{3}\pi$ = 5.23 radians

E3. (2020 P1 Q11)

The minute hand of a large clock is 3.00 m long.

What is the magnitude of its angular velocity?

A $1.39 \times 10^{-4}\,\text{rad s}^{-1}$

B $1.75 \times 10^{-3}\,\text{rad s}^{-1}$

C $5.24 \times 10^{-3}\,\text{rad s}^{-1}$

D $1.05 \times 10^{-1}\,\text{rad s}^{-1}$

[B]

$\omega = \frac{2\pi}{T} = \frac{2\pi}{60\times60} = 1.75 \times 10^{-3}\ rad\ s^{-1}$

E4. (2016 P1 Q12)

What is the angular velocity of the Earth as it rotates on its axis?

A $1.75 \times 10^{-3}\,\text{rad s}^{-1}$

B $1.99 \times 10^{-7}\,\text{rad s}^{-1}$

C $4.36 \times 10^{-3}\,\text{rad s}^{-1}$

D $7.27 \times 10^{-5}\,\text{rad s}^{-1}$

[D]

$\omega = \frac{2\pi}{T} = \frac{2\pi}{24\times60\times60} = 7.27 \times 10^{-5}\ rad\ s^{-1}$

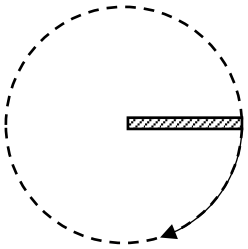
E5. Assuming that the earth moves in a circle at a constant rate around the sun, calculate the angular velocity of the earth around the sun. (Hint: how long does it take for the earth to go round the sun once?) [$1.99 \times 10^{-7} rad\ s^{-1}$]

$\frac{2\pi}{365\times24\times60\times60} = 1.99 \times 10^{-7} rad\ s^{-1}$ (The earth takes 365 days to go round the sun. The earth takes 24 hours to rotate about its own axis which results in the day and night cycle.)

E6. A car is moving around a circular track of radius $400\ m$ at constant angular velocity $0.050\ rad\ s^{-1}$. Calculate the total distance the car moves in 5 minutes. [6000 m]

Angular displacement in 5 min = $\omega t = 0.05 \times 5 \times 60 = 15\ rad$
Distance moved in 5 min = $r\theta = 15 \times 400 = 6000\ m$

E7. A rod is made to spin at a constant rate of 3 complete revolutions per second as shown below.

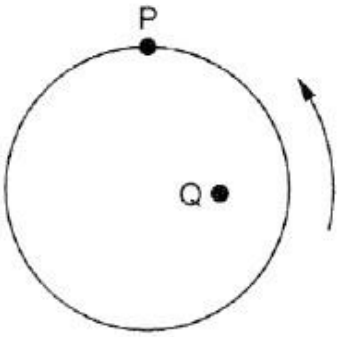


What is the difference in angle between the rod's current position and its position 0.50 seconds later? [$\pi\ rad$]

Angular displacement in 0.50 s = $\omega t = \frac{3\times2\pi}{1} \times 0.50 = 3\pi$
The rod would have moved 1.5 complete circles.
Hence the difference in angle = $3\pi - 2\pi = \pi\ rad = 3.14\ rad$

E8. (2017 P1 Q9)

P and Q are points on a disc that is rotating with uniform circular motion about its centre.



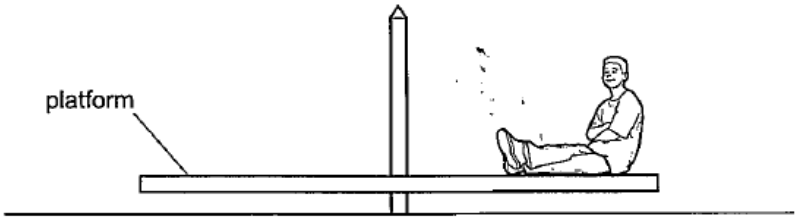
How do the angular velocities of P and Q compare and how do the angular displacements of P and Q compare after a quarter of a revolution?

	angular velocity after a quarter of a revolution	angular displacement after a quarter of a revolution
A	different	different
B	different	the same
C	the same	different
D	the same	the same

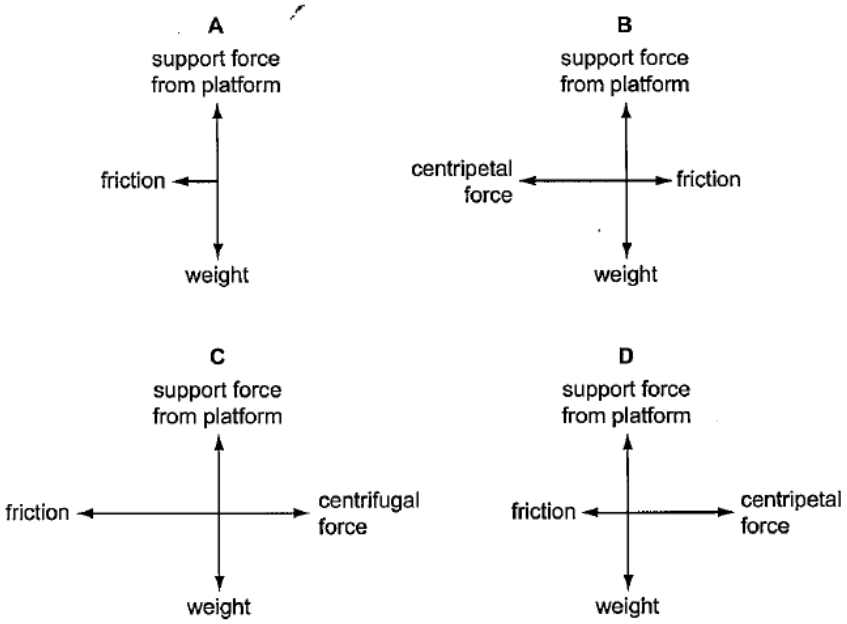
D (both have the same angular velocity, hence angular displacement will be the same, although actual distance travelled will be larger for P)

Centripetal Force

E9. The diagram shows a child sitting on a playground turntable, which is turning with constant angular velocity.



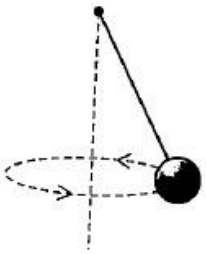
Which diagram shows the forces acting on the child when in the position shown?



A (centripetal force is a resultant force)

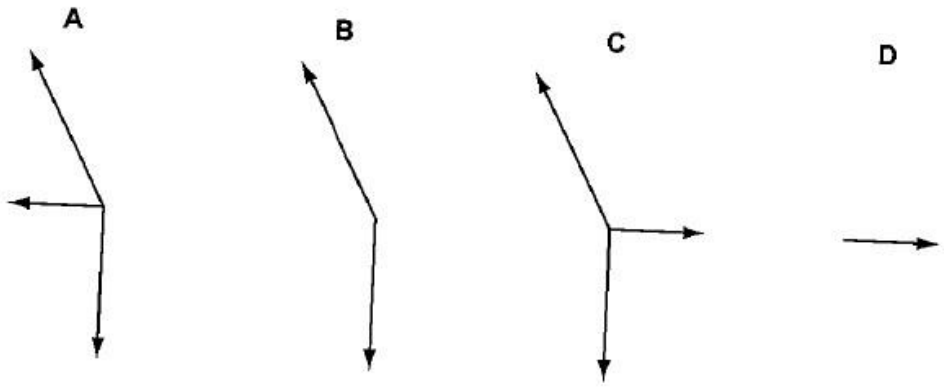
E10. (2013 P1 Q11)

11 A small ball suspended from a light thread moves in a horizontal circle at a constant speed.



A student draws the forces acting on the ball but fails to label them.

Which diagram shows the correct forces?



B (The tension and weight result in a centripetal force to the left pointing to the center of the horizontal circle)