

# Physics Lecture 5

# How to join in remotely

Watch the lecture with your microphone and camera off.

Post any questions or comments in the meetings conversation.

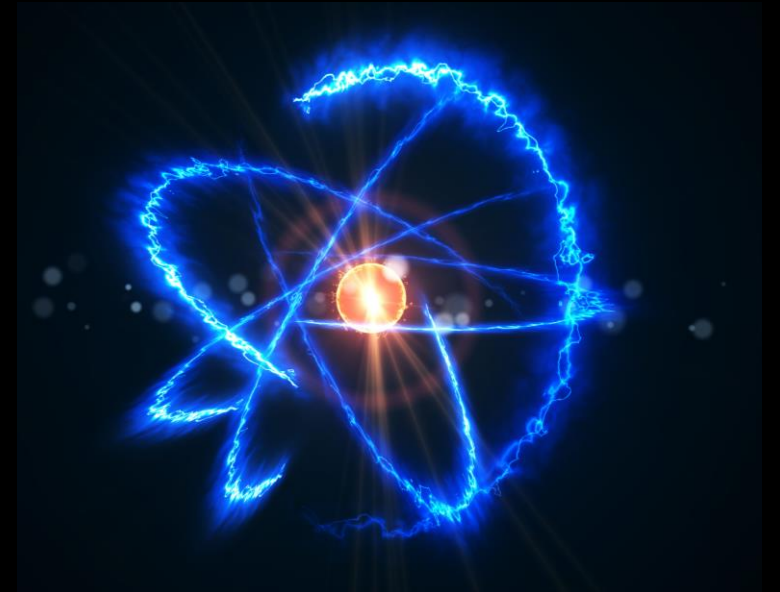
During slides with a black background you should listen and take notes.

During slides with a white background you should complete the task.



# Physics lectures

- Key maths skills
- Introduction to mechanics (Y12 topic)
- Citizen science
- **Introduction to SHM (Y13 topic)**
- Medical physics



# Tasks at home

Complete the post-lecture tasks in OneNote class notebooks. Tasks will be self marked and teacher reviewed.



# Questions?

During the lecture → post on the meeting conversation

After the lecture → email the relevant teacher

[fenners@salesian.hants.sch.uk](mailto:fenners@salesian.hants.sch.uk)

[kenta@salesian.hants.sch.uk](mailto:kenta@salesian.hants.sch.uk)

[rowes@salesian.hants.sch.uk](mailto:rowes@salesian.hants.sch.uk)



Example :

$$120^\circ \times \frac{\pi}{180} = \frac{120^\circ \pi}{180}$$
$$30^\circ \times \frac{\pi}{180} = \frac{30^\circ \pi}{180}$$
$$225^\circ \times \frac{\pi}{180} = \frac{225^\circ \pi}{180}$$

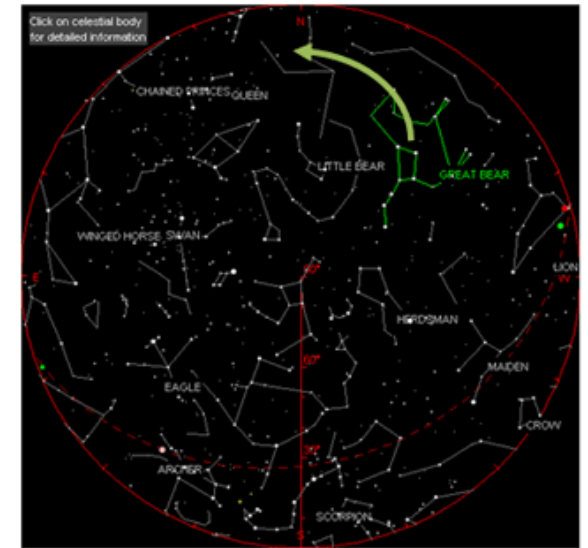
wikiHow to Convert Degrees to Radians

# Degrees and radians

# Degrees



## Constellation Rotation



Oct



Jan



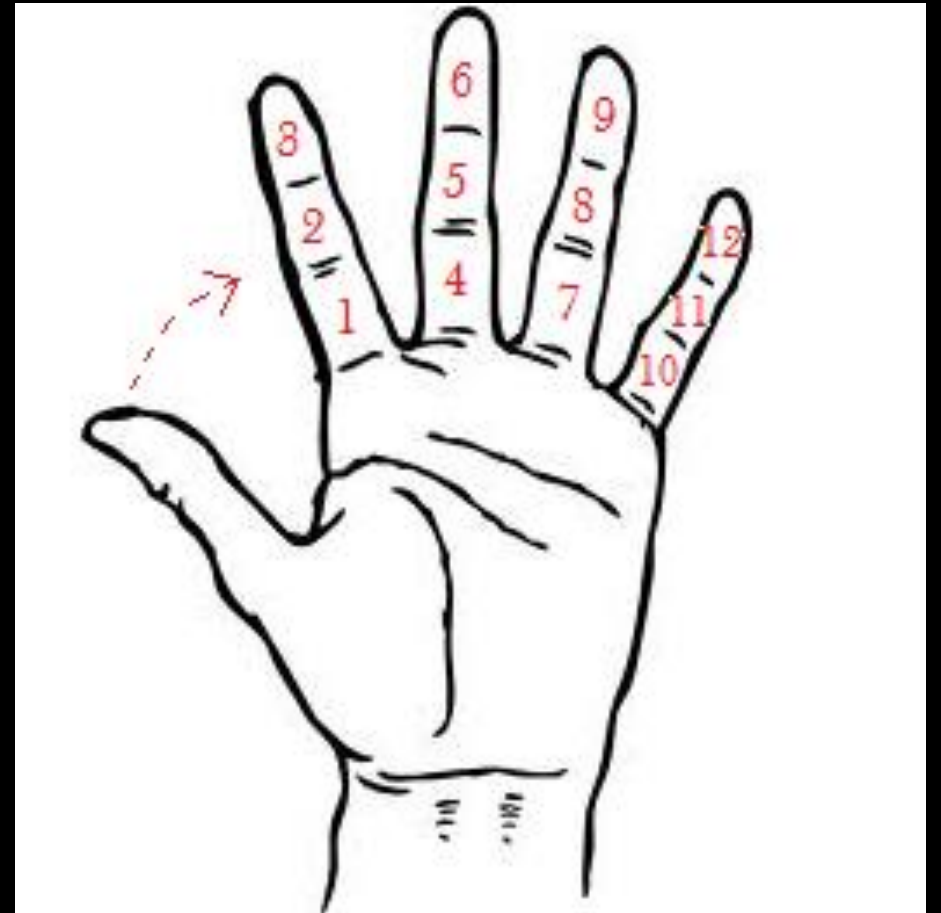
Apr



July

# Degrees

- The Babylonians used a sexagesimal (base 60) number system which ties in with degrees
- There is nothing special about  $360^\circ$  - in fact, people at other times in history have used a full circle being  $100^\circ$  or  $400^\circ$



# Relative to the observer or to the mover?

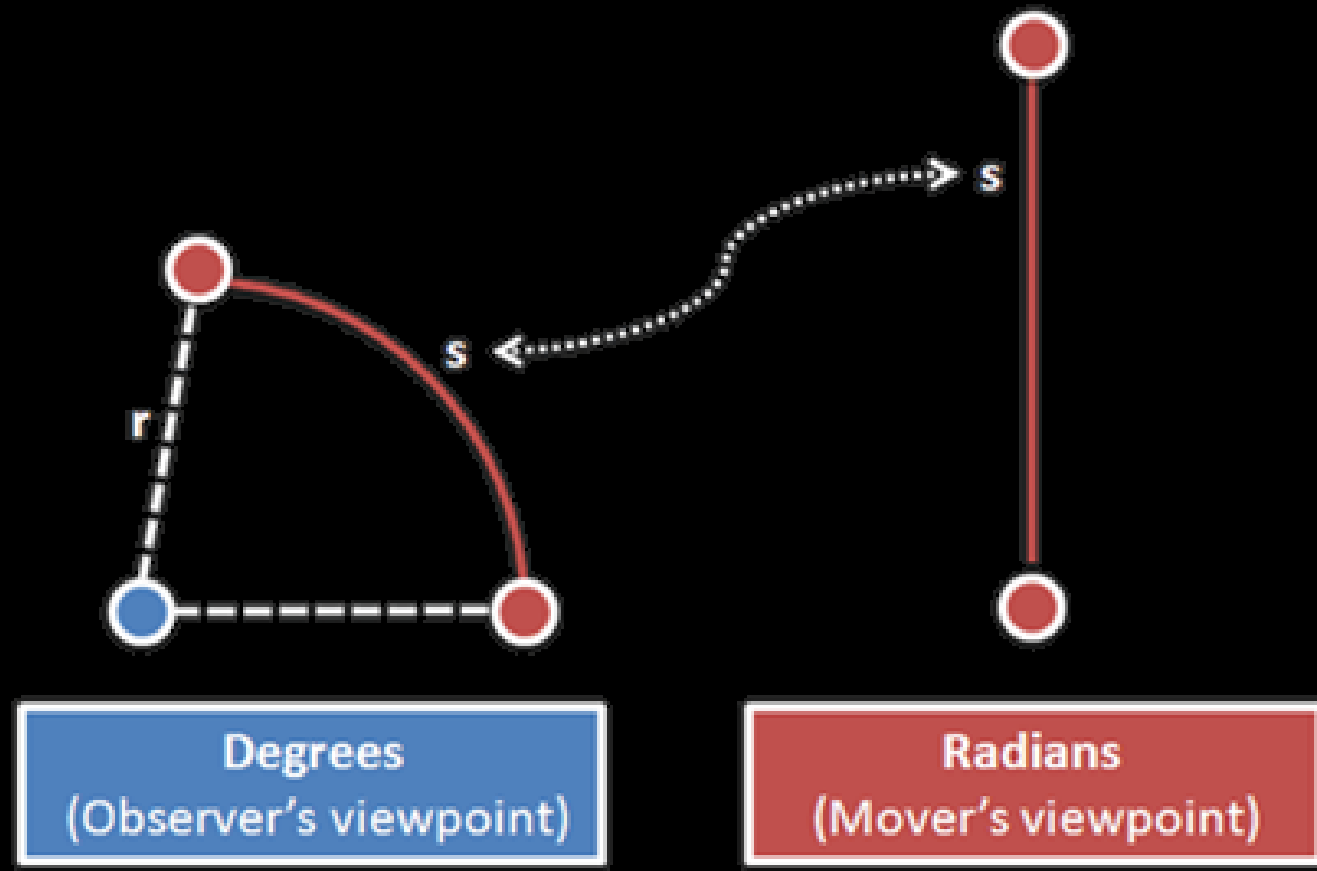
I ran six  
miles at a  
good pace



But how far  
did I turn my  
head to see  
you move?

# Radians

- Radians are the SI unit for measuring angles
- Used for more advanced work with angles e.g. engineering
- Degrees measure angles by 'how far we tilt our heads', but radians measure angles by the distance travelled.

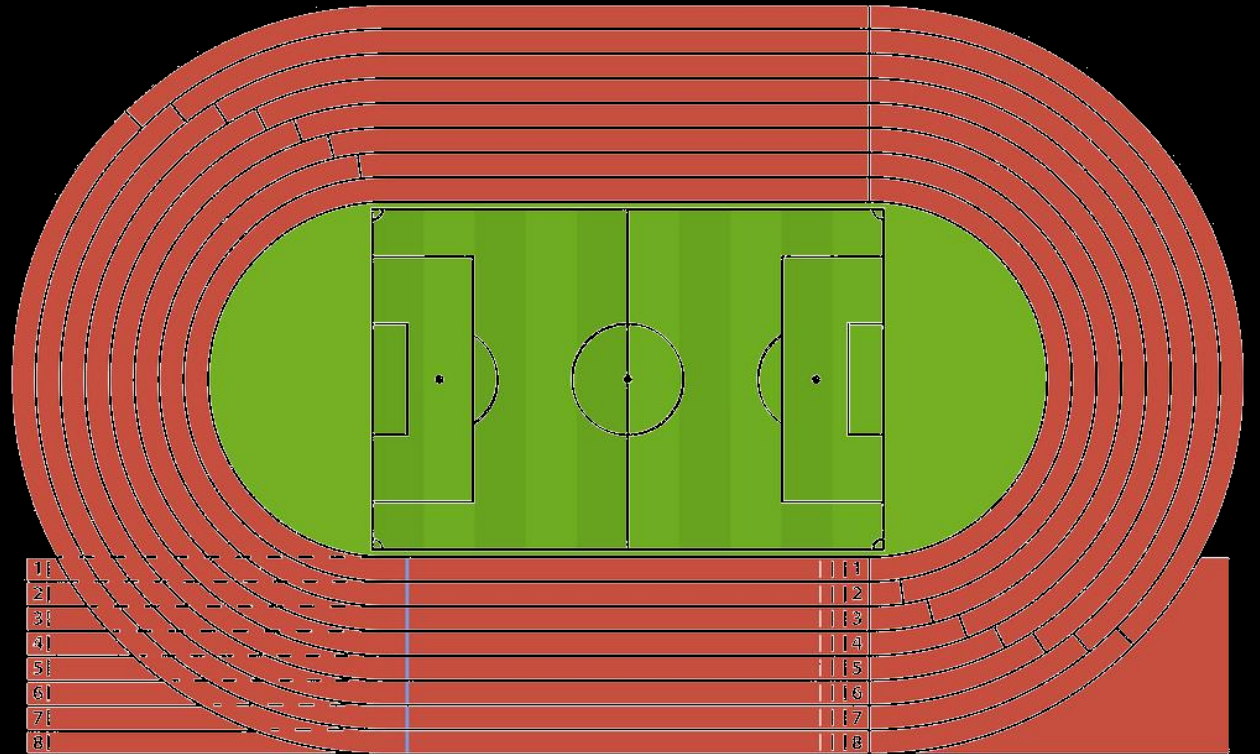


# Radians

However the distance travelled depends on how big the track is. We divide by the radius to get a normalised angle.

$$\text{radian} = \frac{\text{distance}}{\text{radius}}$$

$$\theta = \frac{s}{r}$$

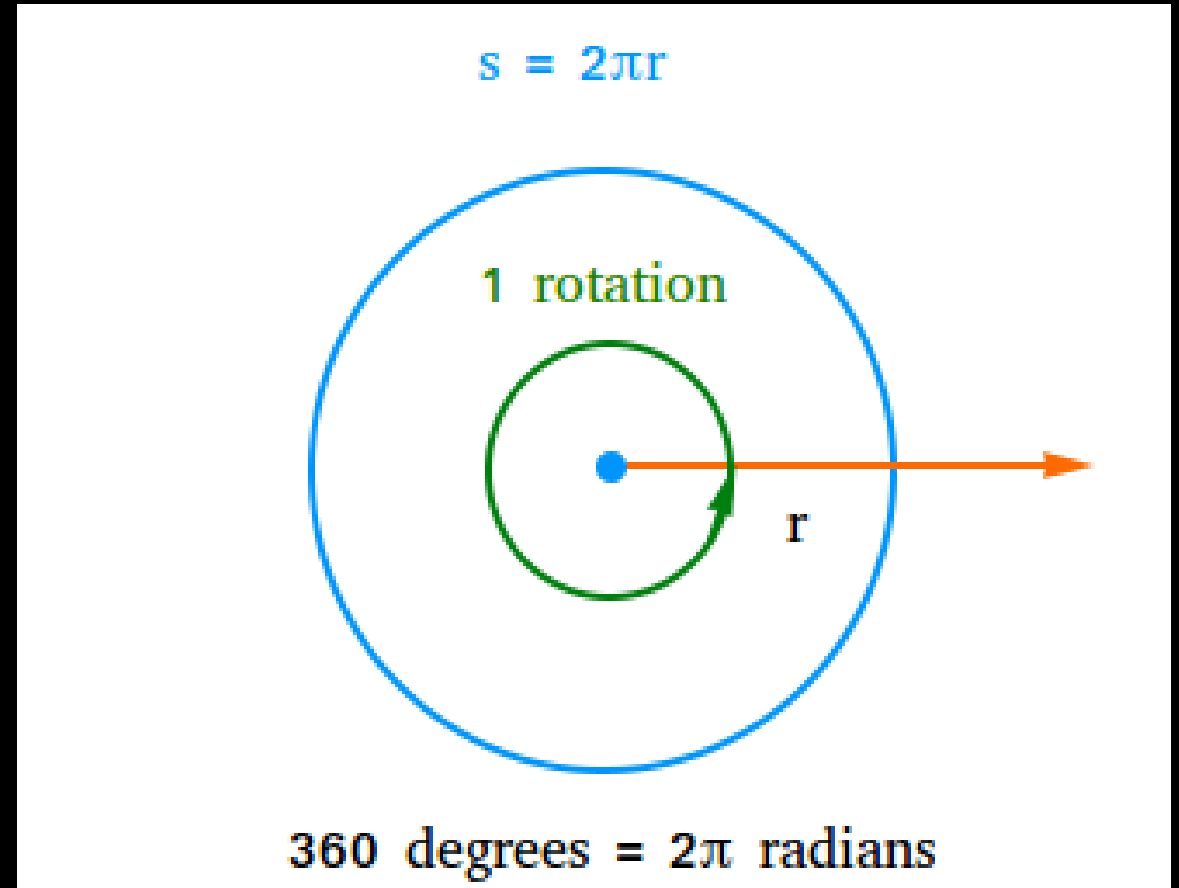


# Radian – or “radius units”

An angle in radians is the arc length  $s$  divided by radius  $r$ .

$$\theta = \frac{s}{r}$$

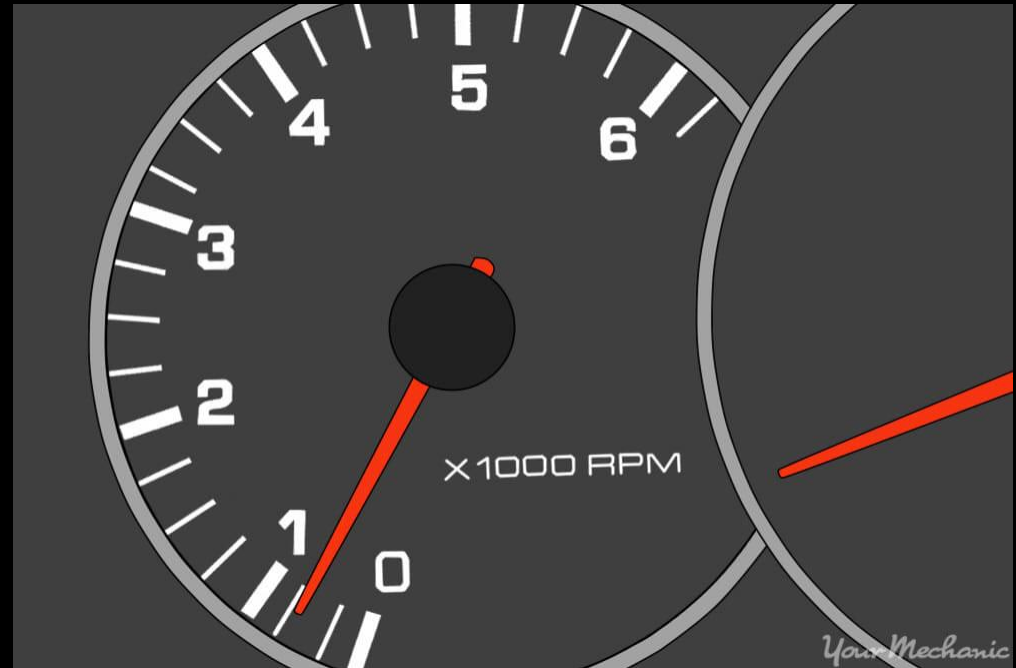
The circumference of a circle is  $2\pi r$ , which is the arc length  $s$ . If we divide by  $r$  then the angle for the whole circle is  $2\pi$  radians, or  $360^\circ$ .



# Using mover's distance, not observer's head tilt

Radians are a count of distance in 'radius units', for example:

- Rotations per minute, not degrees per second in cars
- Satellites orbiting the Earth have speeds in miles per hour, not degrees per hour. Divide by the distance to the satellite and you get the orbital speed in radians per hour.



# Example: Using degrees and radians to find speed

This monster truck has wheel with radius of 2 metres.

**“The wheels are turning 2000 degrees per second”.**

**Working out:** The wheels are going 2000 degrees per second, which means it is turning  $2000/360$  or  $5\frac{5}{9}$  rotations per second. Circumference =  $2\pi r$  so it is moving  $2 \times 3.14 \times 5\frac{5}{9}$ .... Where's my calculator!?



**“The wheels are turning 6 radians per second.”**

**Working out:**  $6 \times 2 = 12$  metres per second.



# Converting between degrees and radians

Join at [www.quizlet.live](https://www.quizlet.live)

<https://quizlet.com/live>

Code posted via Teams

The Quizlet logo is a white circle with a blue border, containing the word "Quizlet" in white text on a blue rectangular background. It is positioned on the right side of the slide, overlapping a blue vertical bar.

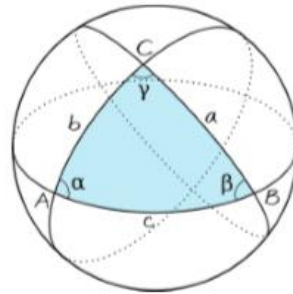
Quizlet

# Extension

For other interesting reasons why radians are a useful unit, see the extension folder of OneNote – Why\_Use\_Radians.pdf

## 6. Spherical geometry

If a triangle is drawn on a unit sphere (a sphere of radius 1) the angles will add up to at least 180 degrees



If angles are measured in radians there is an exact relationship between the area of the triangle (A) and the sum of the angles  $\alpha, \beta, \gamma$

$$A = \alpha + \beta + \gamma - \pi$$

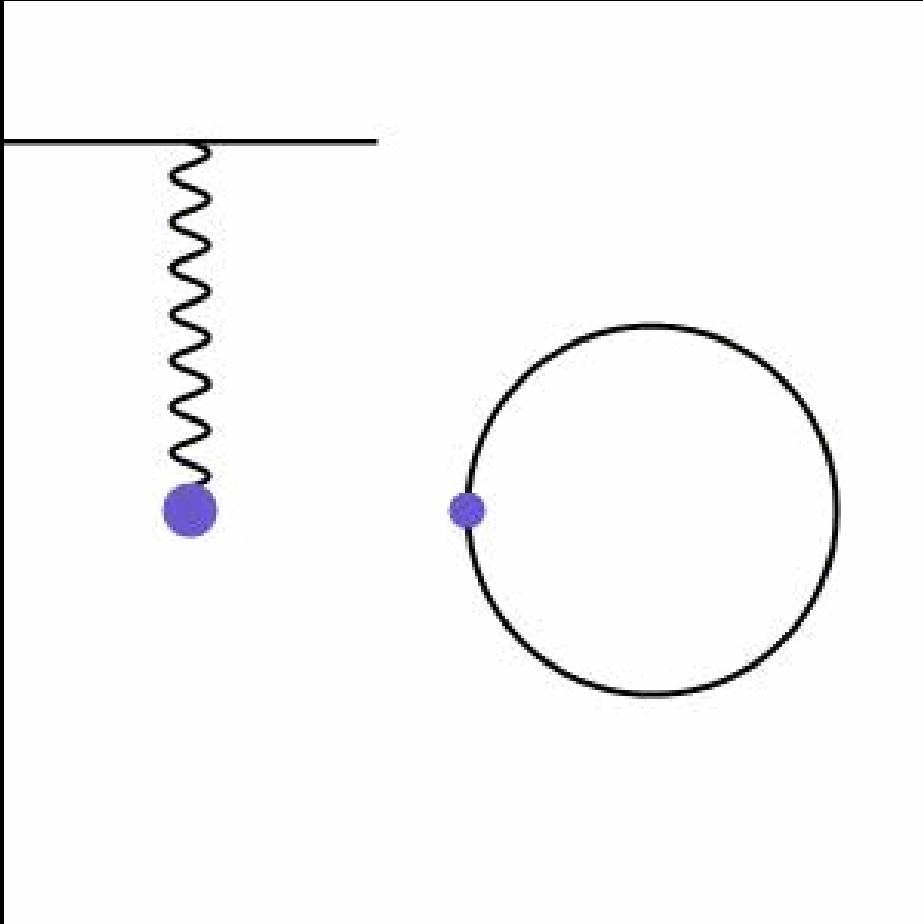


# Periodic Motion

# What is periodic motion?



# Defining periodic motion

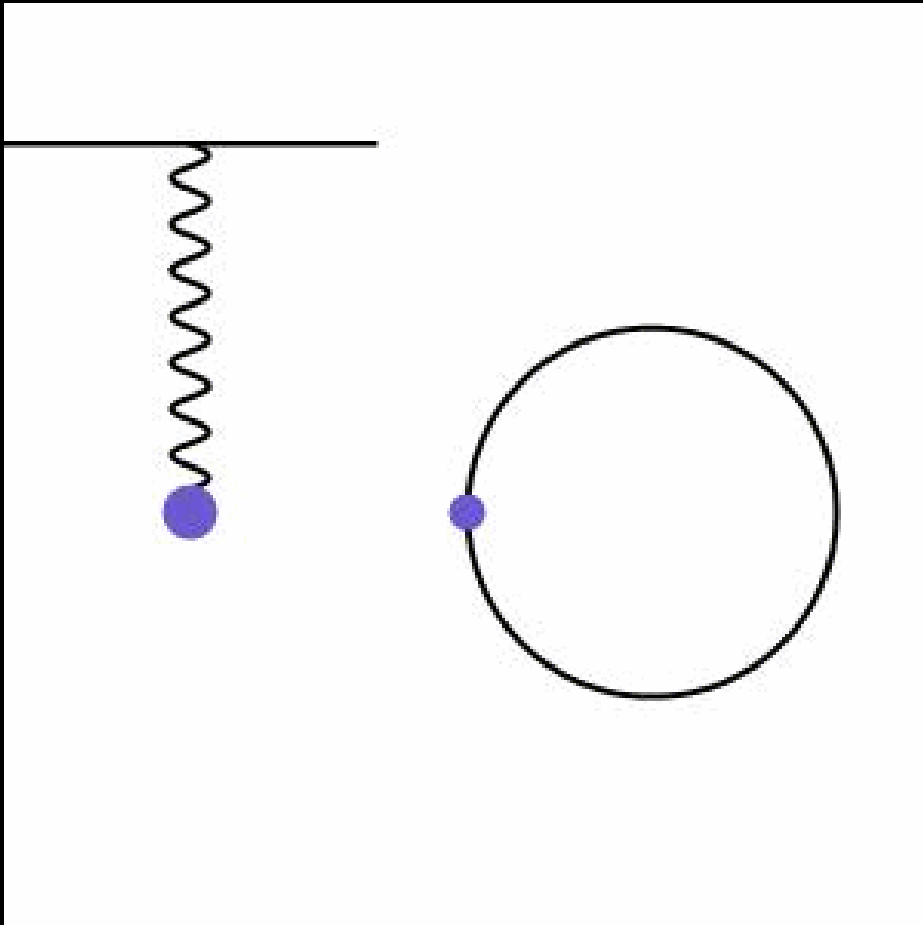


Time period =  $T$

Frequency =  $f$

$$T = \frac{1}{f}$$

# Defining periodic motion

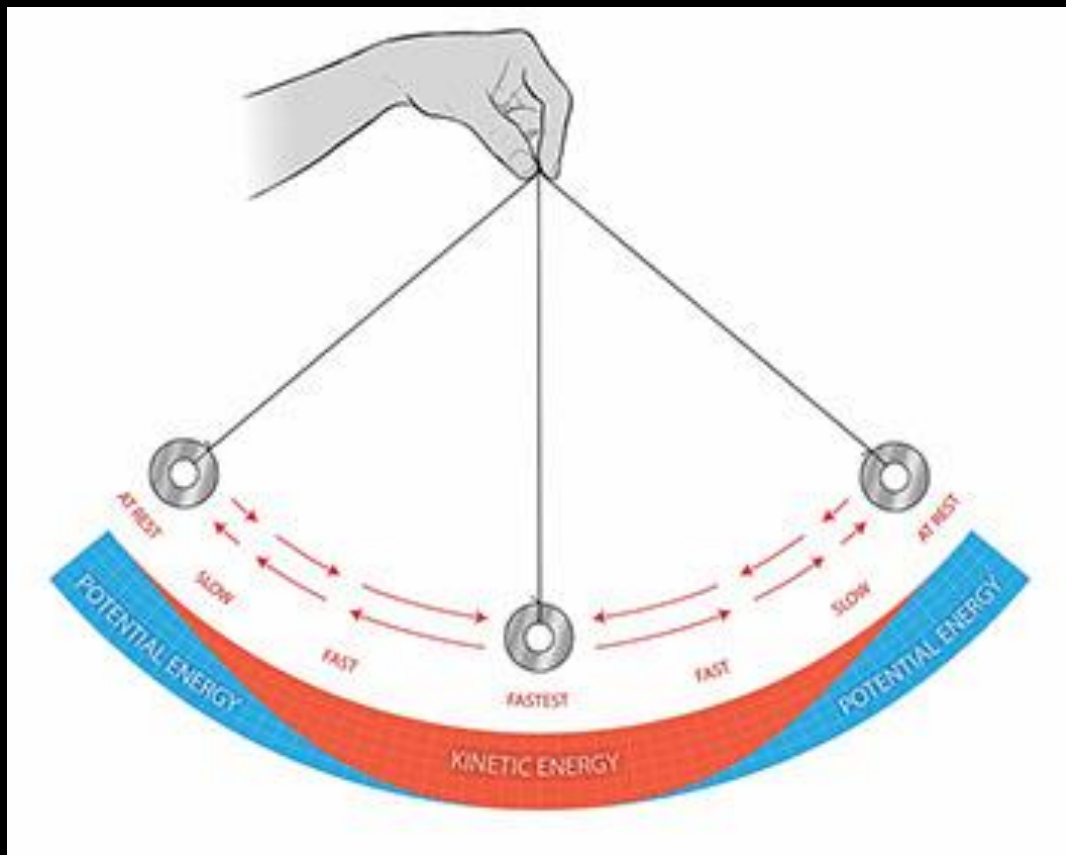


Displacement  $x$  = vector distance moved from equilibrium

Amplitude  $A$  = maximum distance from equilibrium

Angular frequency  $\omega$  = measure of rate of rotation of the cycle, in radians per second

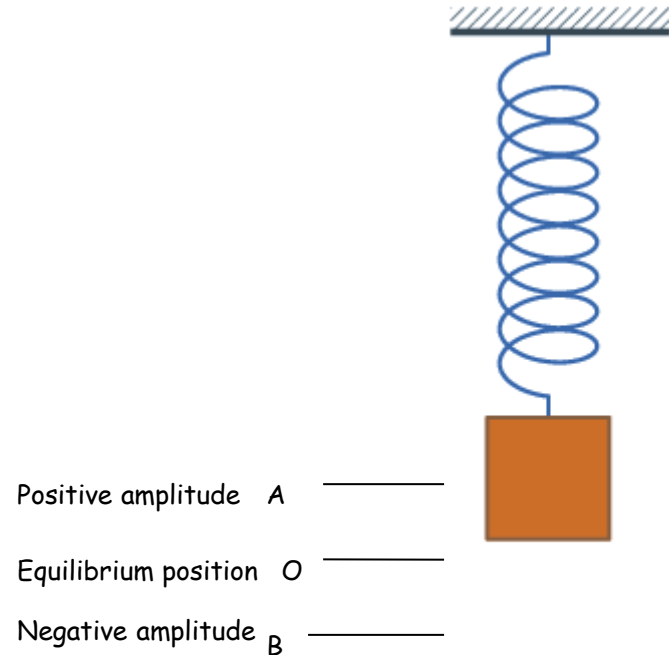
$$\omega = 2\pi f = \frac{2\pi}{T}$$



# Simple Harmonic Motion

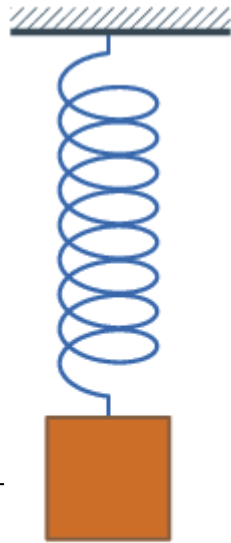
## Characteristics of simple harmonic motion:

1. It is periodic oscillatory motion about a central equilibrium point,



## Characteristics of simple harmonic motion:

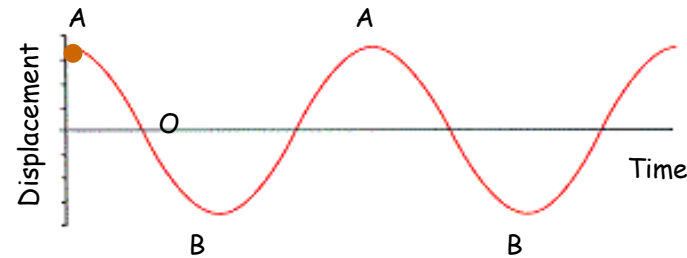
1. It is periodic oscillatory motion about a central equilibrium point,
2. the displacement is a sinusoidal function of time, it ranges from zero to a maximum displacement (amplitude),



Positive amplitude  $A$  \_\_\_\_\_

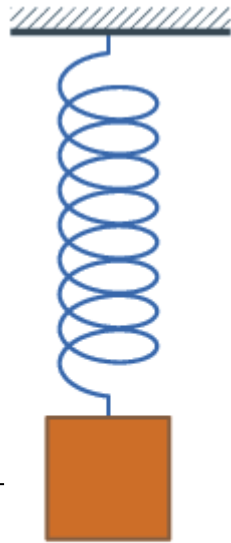
Equilibrium position  $O$  \_\_\_\_\_

Negative amplitude  $B$  \_\_\_\_\_



## Characteristics of simple harmonic motion:

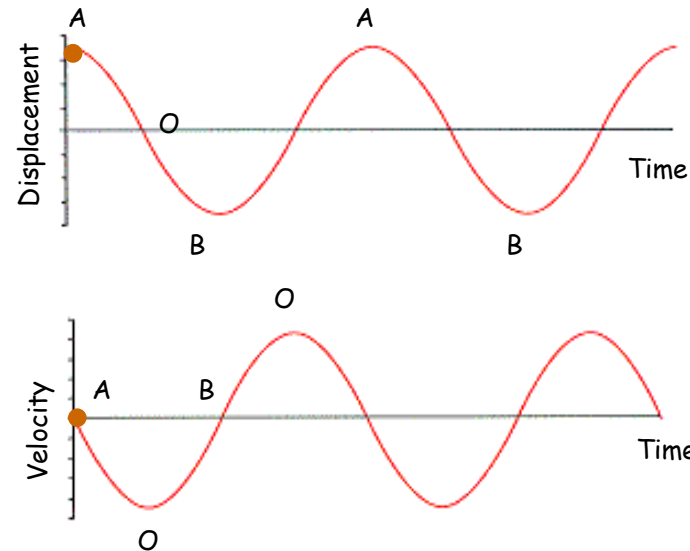
1. It is periodic oscillatory motion about a central equilibrium point,
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3. Velocity is maximum when displacement is zero,



Positive amplitude A \_\_\_\_\_

Equilibrium position O \_\_\_\_\_

Negative amplitude B \_\_\_\_\_

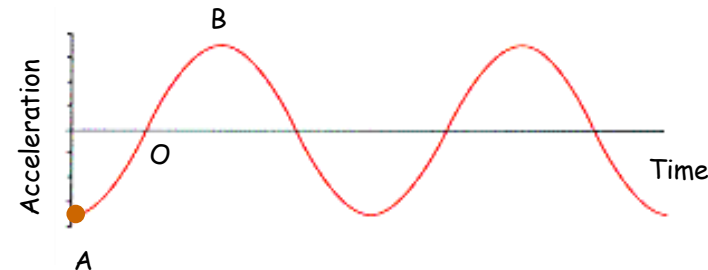
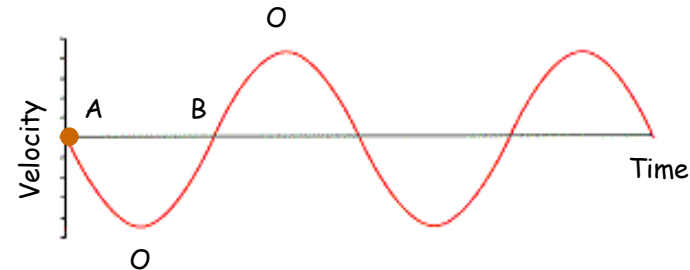
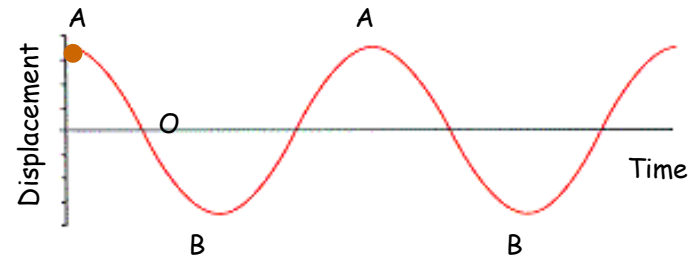
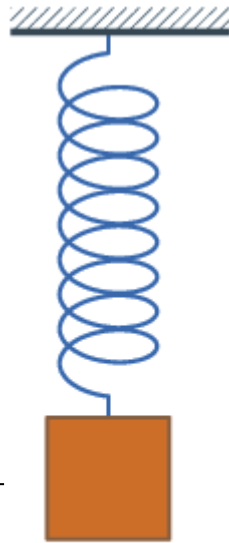


remember  
velocity is the  
gradient of  
displacement

## Characteristics of simple harmonic motion:

1. It is periodic oscillatory motion about a central equilibrium point,
2. the displacement is a sinusoidal function of time, it ranges from zero to a maximum displacement (amplitude),
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4. Acceleration is always directed toward the equilibrium point, and is proportional to the displacement but in the opposite direction,

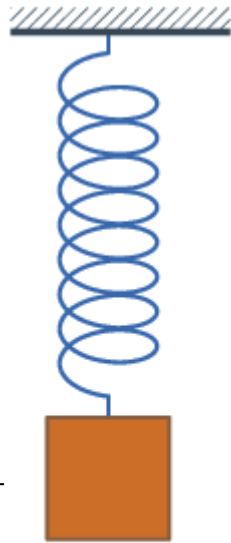
Positive amplitude A \_\_\_\_\_  
Equilibrium position O \_\_\_\_\_  
Negative amplitude B \_\_\_\_\_



remember  
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## Characteristics of simple harmonic motion:

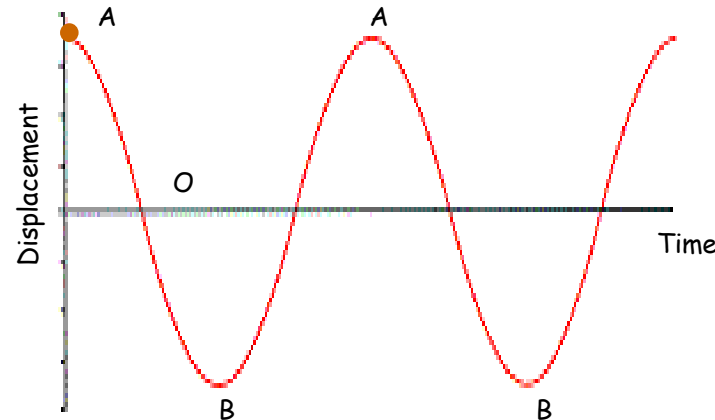
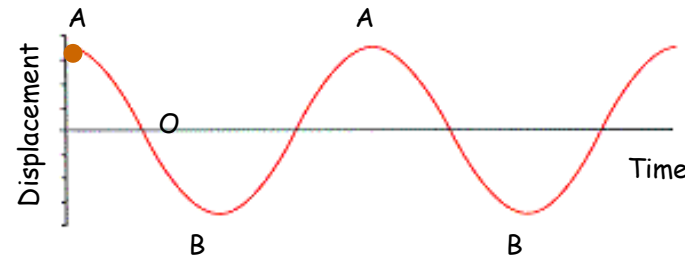
1. It is periodic oscillatory motion about a central equilibrium point,
2. the displacement is a sinusoidal function of time, it ranges from zero to a maximum displacement (amplitude),
3. Velocity is maximum when displacement is zero,
4. Acceleration is always directed toward the equilibrium point, and is proportional to the displacement but in the opposite direction,
5. The period does not depend on the amplitude.

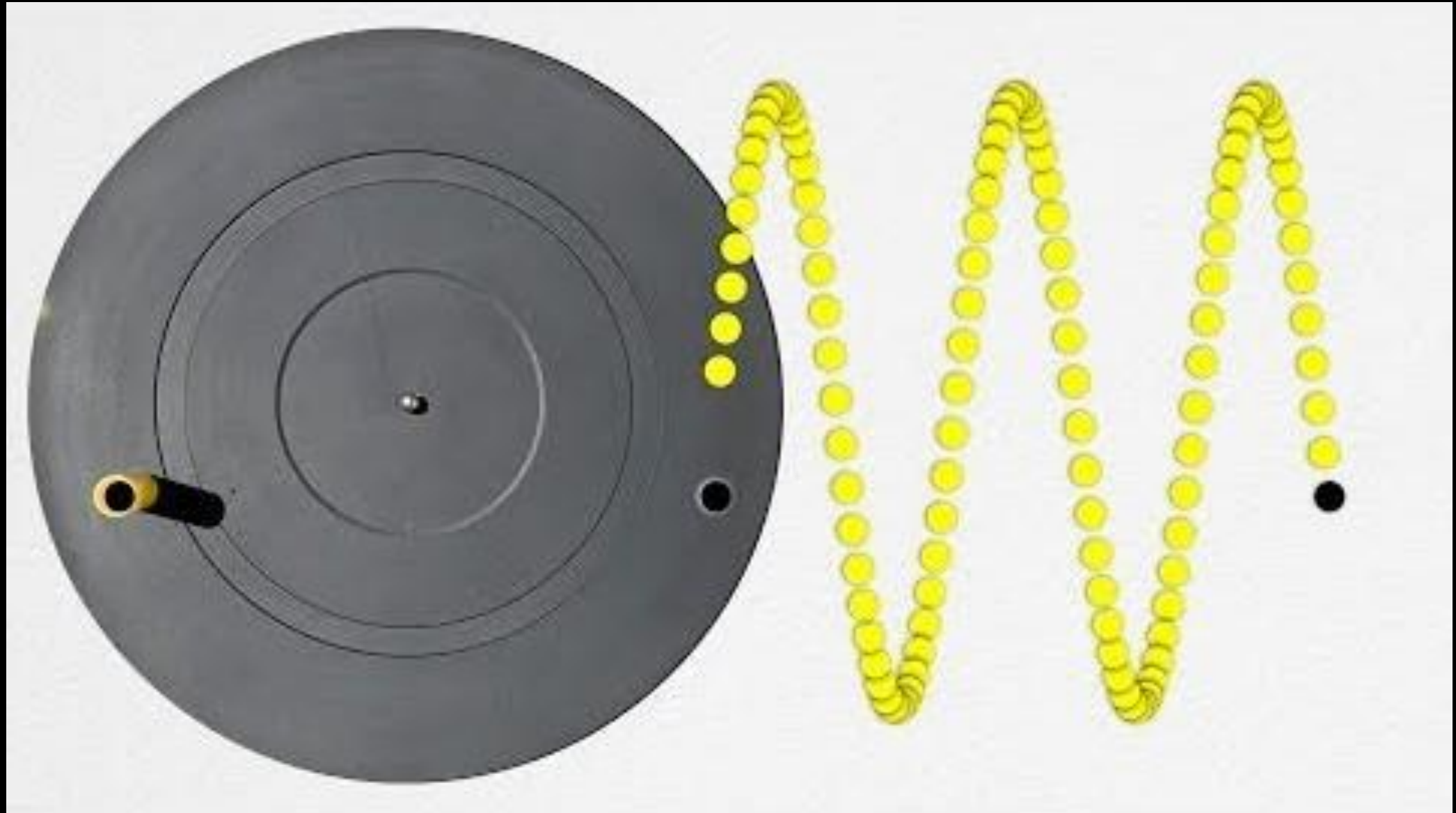


Positive amplitude A \_\_\_\_\_

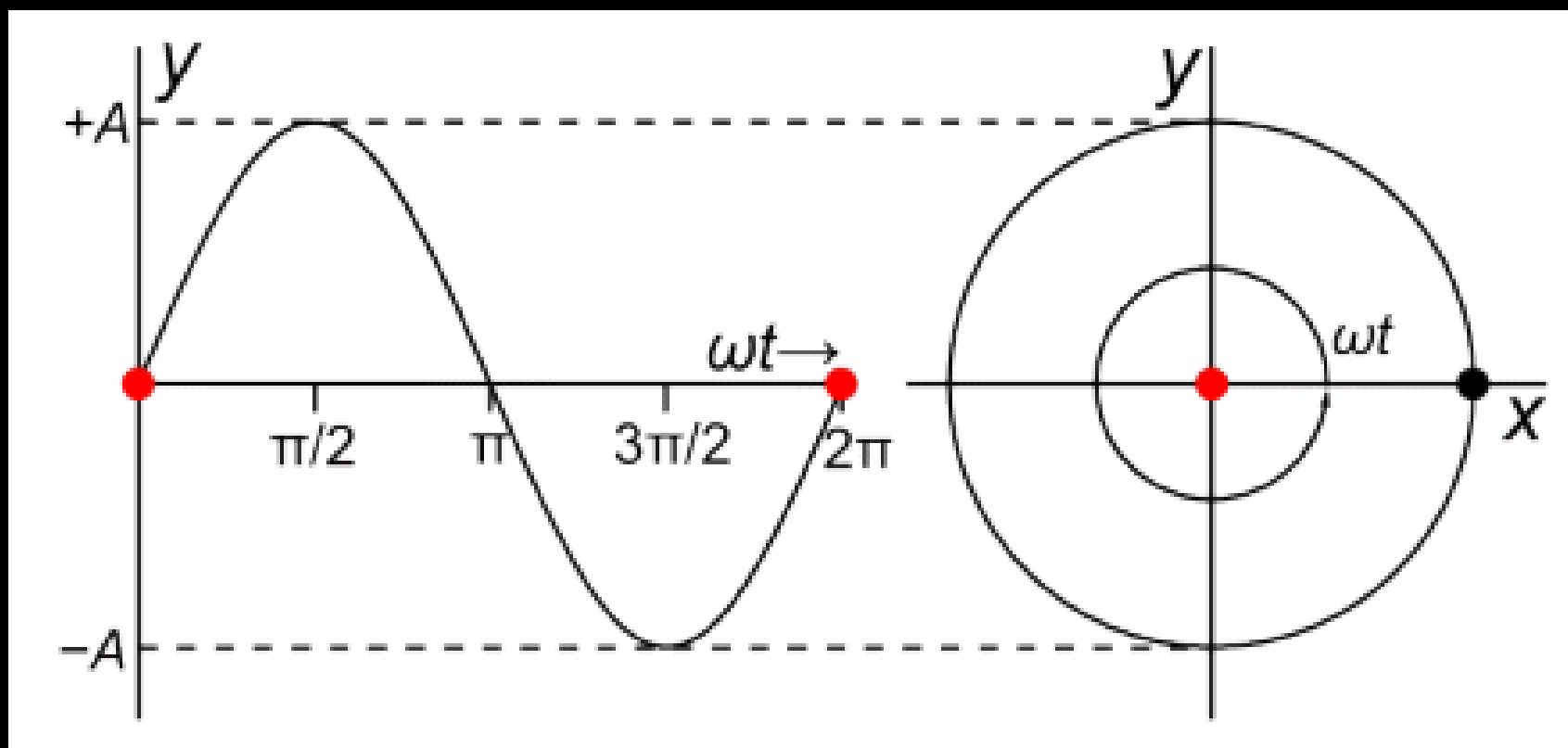
Equilibrium position O \_\_\_\_\_

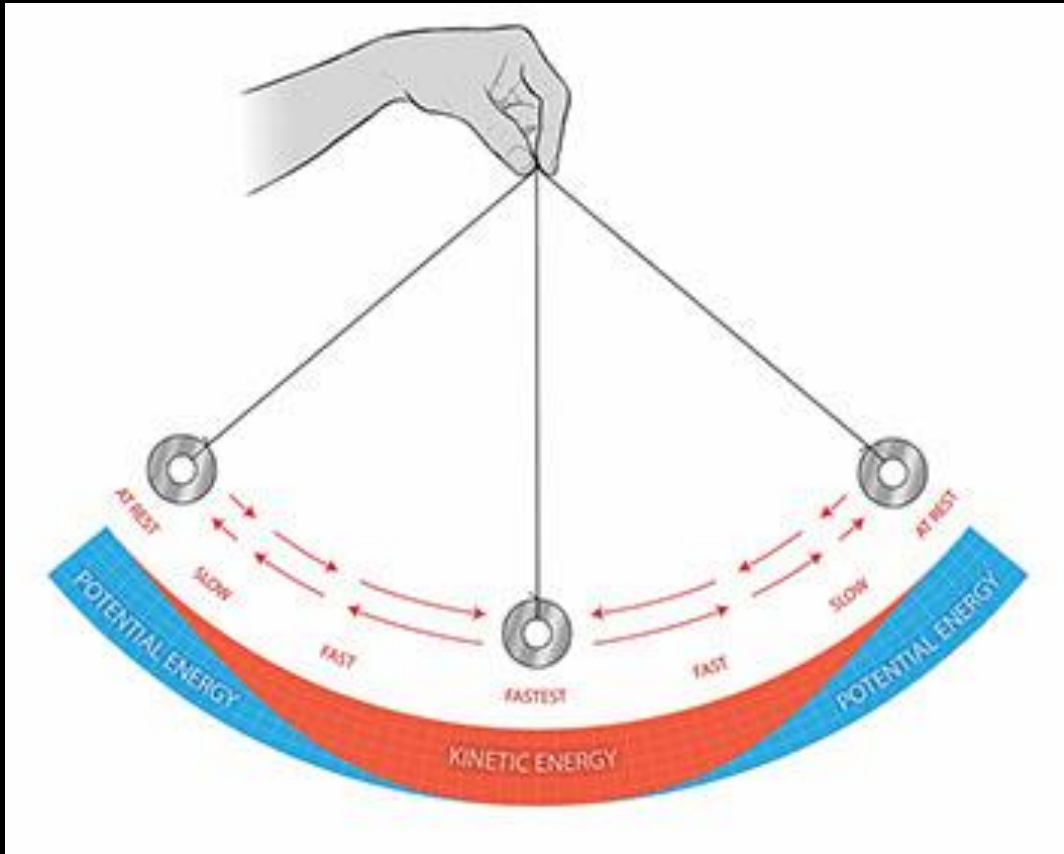
Negative amplitude B \_\_\_\_\_





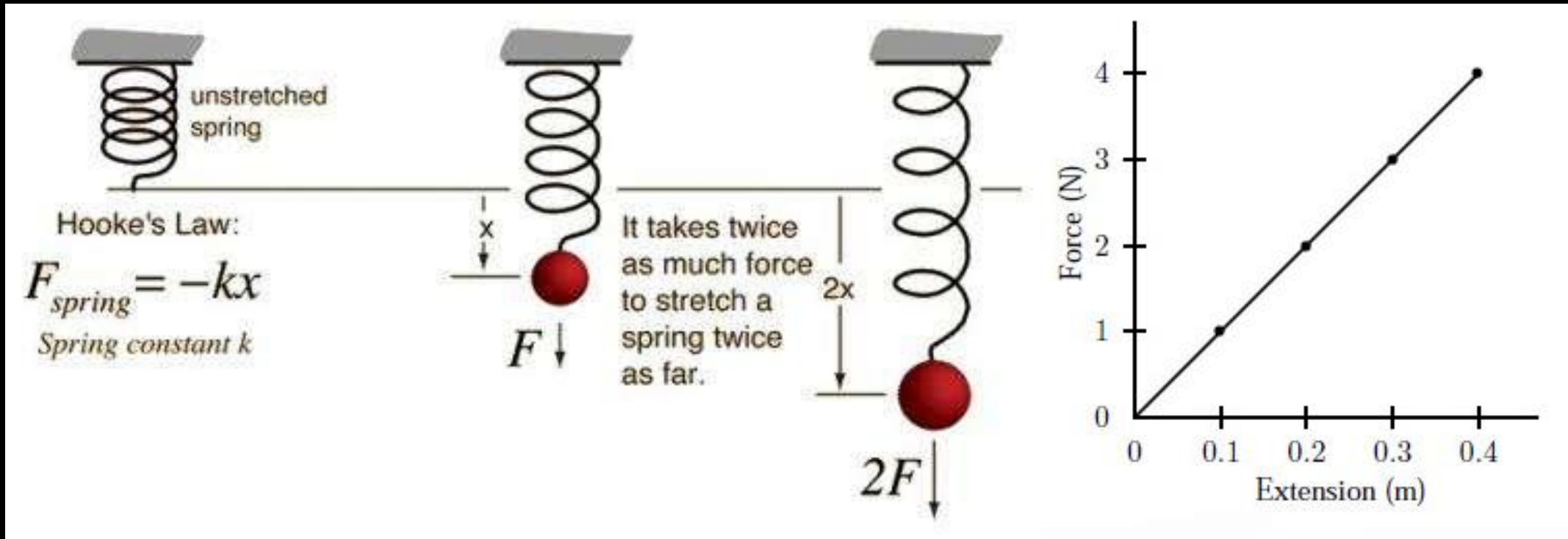
# Using radians to describe periodic motion





# Examples of Simple Harmonic Motion

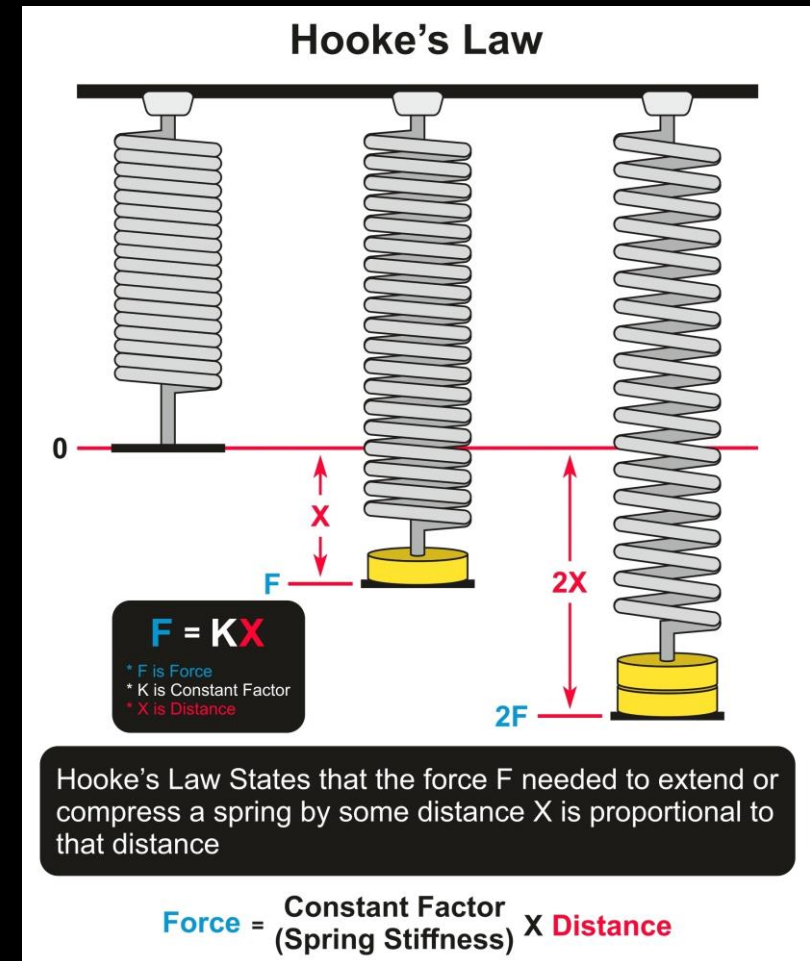
# Hooke's Law recap



# Mass on a spring

A restoring force is acting which is directly proportional to the displacement, for example a mass on a spring.

$$F = -kx$$

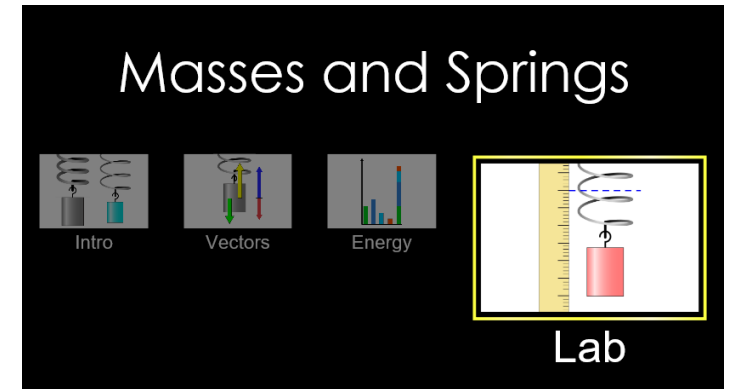


# Investigating mass on a spring

[https://phet.colorado.edu/sims/html/masses-and-springs/latest/masses-and-springs\\_en.html](https://phet.colorado.edu/sims/html/masses-and-springs/latest/masses-and-springs_en.html)

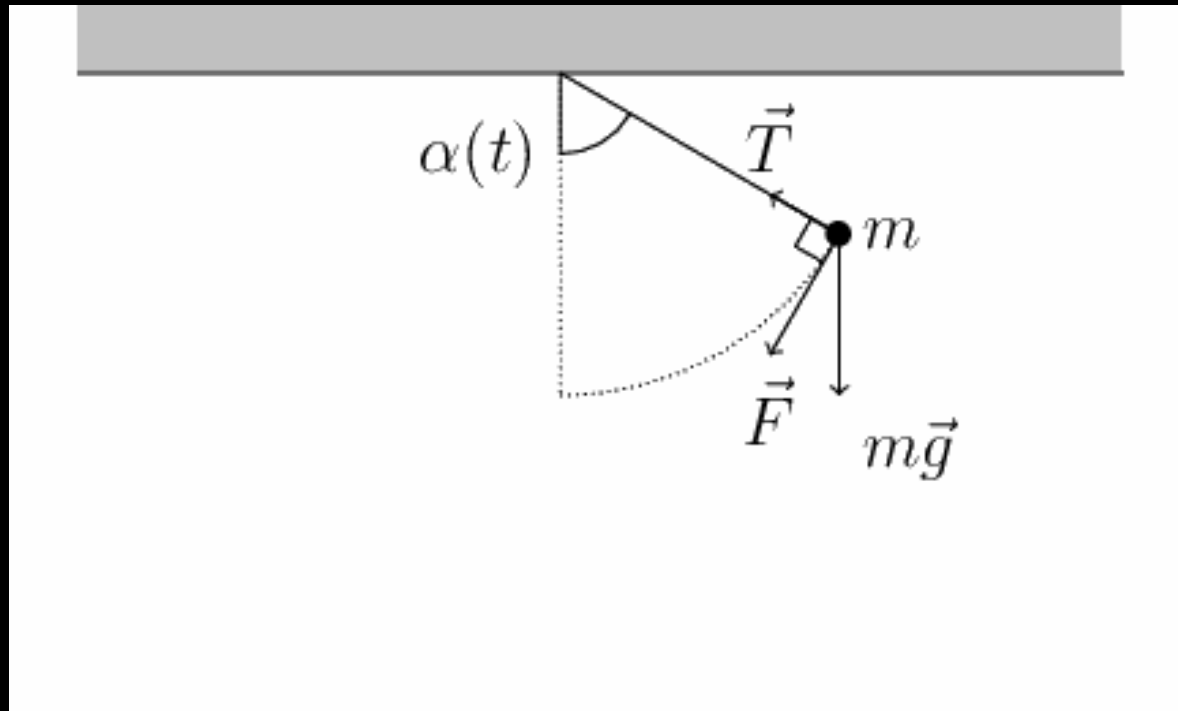
Post on Teams:

1. What effect does the mass have on the time period and on the amplitude?
2. What effect does the spring constant have on the time period and on the amplitude?
3. Extension: what is damping?



# Simple pendulum

A restoring force is acting which is directly proportional to the displacement.





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physical phone experiments



smartphone  
pendulum



phyphox  
physical phone experiments

# Investigating a simple pendulum

Download the phyphox app

Build a pendulum with a piece of string/sticky tape and your phone

Measure the length of your pendulum with a tape measure/ruler

Open the pendulum tool (under 'Mechanics')

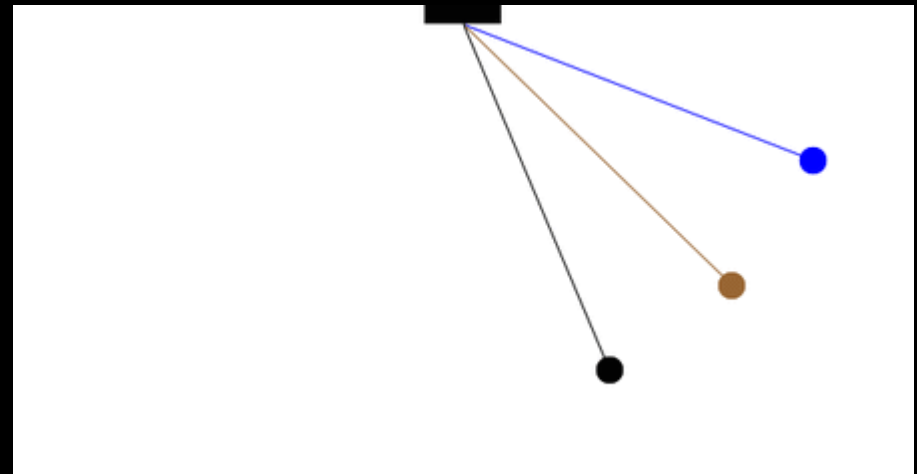
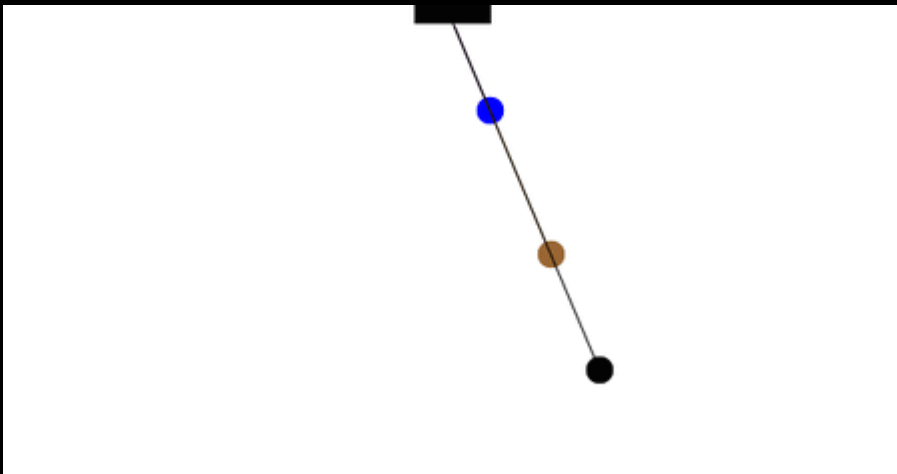
Measure the time period of your pendulum with the app

Post both of your results on Forms using the QR code



# Simple pendulum

The period of a pendulum does not depend on the mass of the ball, but only on the length of the string. The pendulum with the longer string will have the longer period.



# Post lecture tasks

Open the Yr11 Physics Lectures class notebook.

Under 'Post Lecture Tasks' are some instructions for a practical task.

Complete and upload your work.

Answers to the questions about the practical task are in the Content Library section.

Self mark your work in green before the next lecture.