

Doppler Ducklings & the EXPANDING UNIVERSE




Your name : _____

Your duck's name : _____

1. Play with the wave!: Breathing Duck

slow

fast

Move the duck
in an up-down
motion 

- Observe the
wave pattern
on water surface.

- Try changing the
frequency of your
hand movement
What happen?

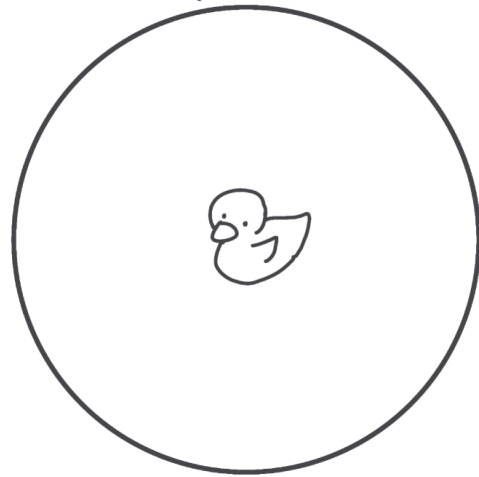
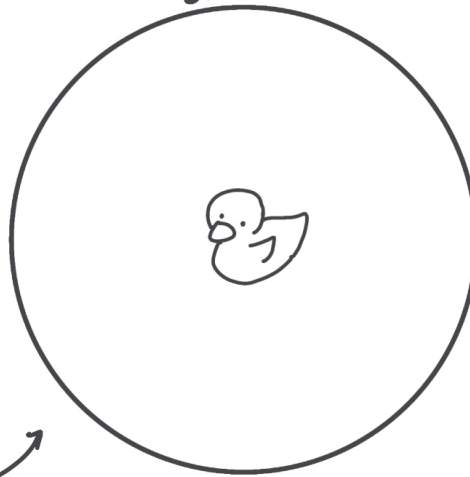
- What did you
notice about
the gap between
each crest?

- Can you come up
with a relationship
between your rate
of movement and
this gap? (in words)

- Now rewrite that
relationship using;

f = frequency
of hand movement

λ = gap width
between the crest



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λ

2. Physics time!: Speedy Duck

- Now, can you find out how fast the wave is moving from the duck?



eqn 1

RECALL

$$v = \frac{s}{t}$$

velocity is distance covered by an object in a unit time

distance s would be the gap between the crest or " λ - wavelength"

- How do we relate " f - frequency" with time t ?

☁ If you move the duck up-down 15 rounds in 30 seconds

→ How many rounds did the duck move in 1 second?

this is frequency (f) = $\frac{\text{rounds}}{\text{seconds}} = \text{rounds/1 second or Hertz}$

→ How long did it take for the duck to move 1 round?

this is period (T) = $\frac{\text{seconds}}{\text{rounds}} = \text{seconds/1 round}$

- Can you write f in terms of T ?

$$f =$$

eqn 2

- Using the information you have,
Write down the relationship between

v - wave speed

λ - wavelength

f - frequency

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Hint: Use eqn 1 and eqn 2



3. Doppler Effect : swimming duck



Move the duck forward
Observe the water surface
in front and behind the duck

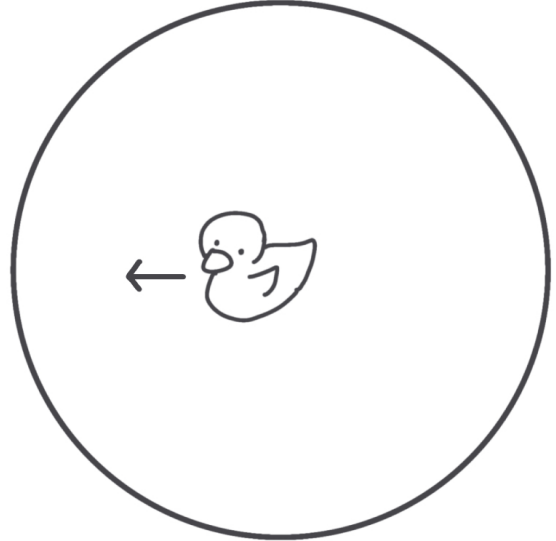
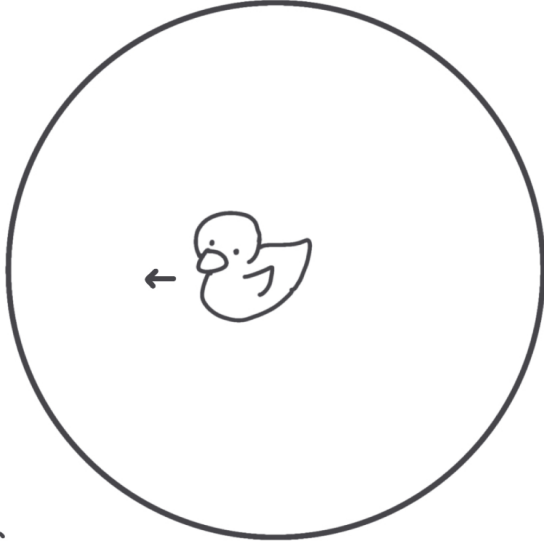


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- Try changing the swimming speed, draw what happens!

slow

fast

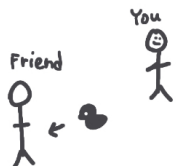


in front : _____

behind : _____

- Imagine you are observing from behind the duck and your friend is observing from in front of the swimming duck compare the wavelength and the frequency you would observe vs what your friend would observe

by putting $>$, $<$, or $=$ in the boxes



How big is the gap between crests when it arrive \rightarrow

λ front



λ behind

How many crests arrive to you over same time interval \rightarrow

f front



f behind

Hint: use the relationship you obtained in 2. to check your answers

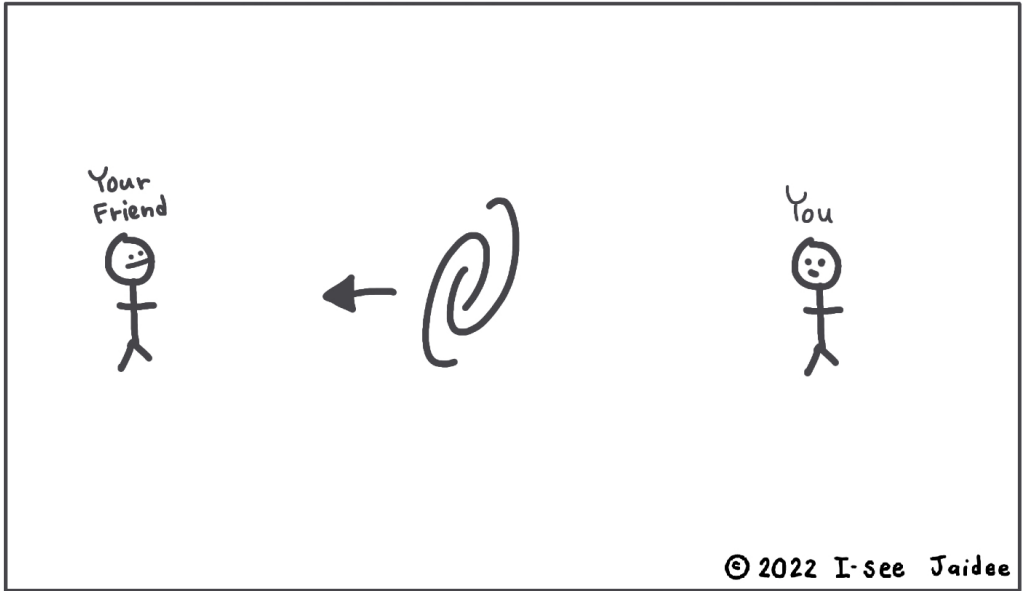
4. Next step: from Lake Waban to the Universe!

Duck \rightarrow Galaxy

Water wave \rightarrow Light wave



- Draw the wave fronts emitted from this moving galaxy



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We can see how we can compare water wave's λ and f by looking at its ripples. What about some other waves we can't see its form directly? For example, sound wave its high-low pitches are the representations of its frequencies. As for visible light wave; its "color" depends on its wavelength!

challenge: You observe red light coming from a distant galaxy
Can you predict if it's moving towards or away from us? How?

Hint: where is red light on the visible light spectrum?

"Most galaxies are redshifted": what does this imply in terms of the Universe as a whole?