Next Step TEST PREP

Physics (waves)

Today's Info Session

- Welcome to this Info Session!
- Introduction
- Physics
  - Waves
  - Doppler effect
  - Standing waves
- How Can Next Step Help?
- Questions?

Next Step TEST PREP

MCAT

Medical College Admission Test

WHAT IS YOUR NEXT STEP?

Introduction

Hi, I'm Phil!

- MCAT Content writer
- Tutored and taught for 9+ years
- Attended University of Nebraska Medical Center as an MD/PhD student.

✓ Next Step is a team of test prep and educational experts committed to excellence.

Who Is Next Step?

- Began in 2009 as a tutoring company
- Focus on graduate admissions tests only
- Team of educational experts
- First company to have materials built from ground up for 2015 MCAT format
- Now the first company to have new 2018 MCAT Interface

✓ We never stop improving our materials!

Waves

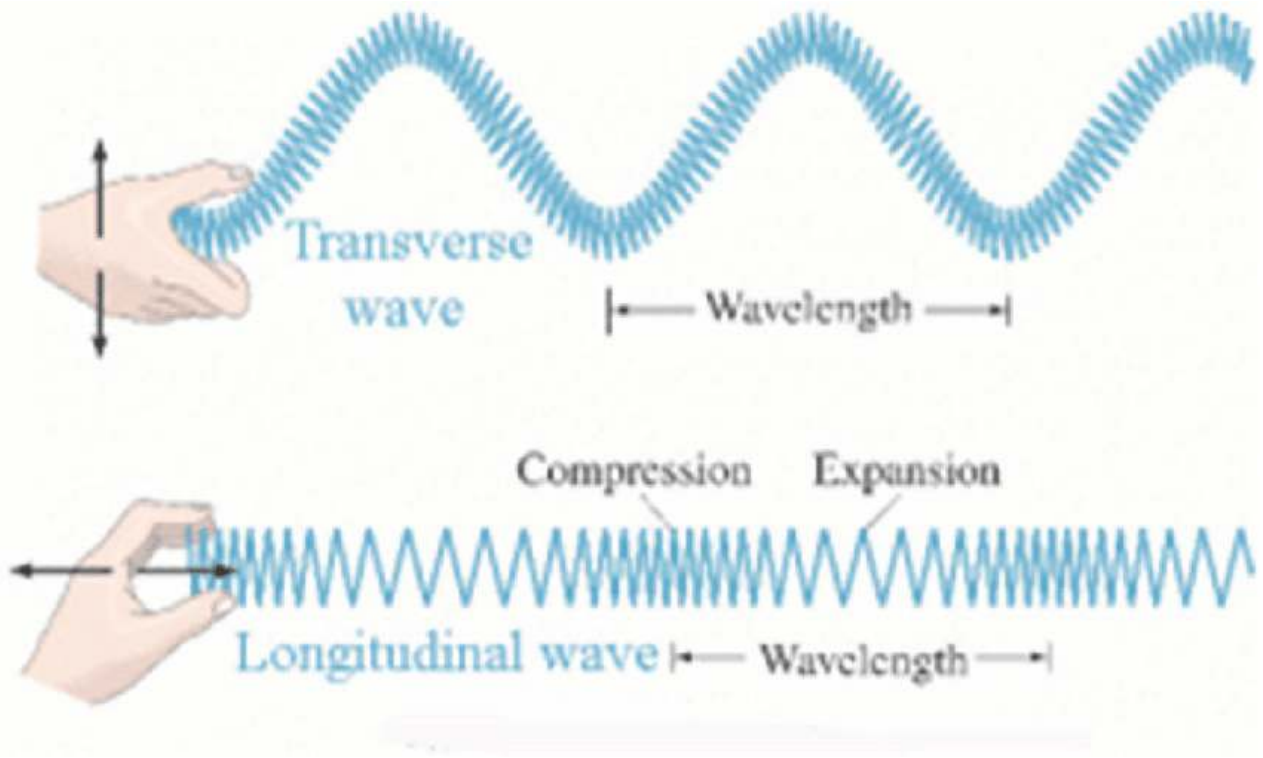
Two main types of waves tested on the MCAT:

Transverse and Longitudinal

Sound?

Light?

Ocean waves?



Waves

Equations!

Velocity of a wave = λf

λ= wavelength

f= frequency

Period?

T= 1/f

How fast do light and sound waves go?

Speed of light:
C= 3 x 10^8 m/s

Speed of sound (in air)
v= 340 m/s

Waves

Doppler effect

$$f' = f\frac{v \pm v_o}{v \mp v_s}$$

Imagine I have a water balloon gun that fires a water balloon every second. How often do you get hit if the balloons travel at a set speed and I am running towards you?

f'= perceived freq
f= source freq
v= speed of wave
Vo = speed of observer
Vs = speed of source

Waves

Doppler effect

There is a boombox playing the macarena and it was traveling towards you at twice the speed of sound. You will hear:

$$f' = f_s \, v \pm v_o / v \mp v_s$$

A. The song at twice the pitch
B. The song backwards
C. The song at half speed
D. The song played normally

What if it was traveling at the speed of sound?

Waves

Nodes occur any place you cross the center. (if it just hits the middle, then we count it as a half.

Antinodes occur when the wave hits the sides

Standing waves (double closed)

Crosses 1 time total = 1 node = first harmonic

2nd harmonic

3rd harmonic

wavelength = 2L/n

n = number of nodes and harmonic

Waves

Nodes occur any place you cross the center. (if it just hits the middle, then we count it as a half.

Antinodes occur when the wave hits the sides

Standing waves (double open)

Crosses 1 time total = 1 node = first harmonic

2nd harmonic

3rd harmonic

wavelength = 2L/n

n = number of nodes and harmonic

Waves

Nodes occur any place you cross the center. (if it just hits the middle, then we count it as a half.

Antinodes occur when the wave hits the sides

Standing waves (half open half closed)

Crosses 1 time total = 1 node = first harmonic

3rd harmonic

5th harmonic

wavelength = 4L/n

n = number of harmonic (MUST BE ODD!)

Practice Passage

As air is forced out of the lungs, the vocal cords that are stretched over the opening in the larynx vibrate to create pressure waves. Muscles attached to the cords can adjust their tension, changing the frequencies of vibration. The body creates specific sound waves by changing the size and shape of its respiratory resonance cavities.

Each human voice has a unique timbre, produced by the shape of the individual's biological resonance chambers. Harmonics known as overtones also contribute to the timbre of the voice. Humans have a lung capacity of about 1200 cm3. The system is analogous to a closed tube with an average diameter of about 2 cm and a length of approximately 10 cm. Adult males have a fundamental frequency from 85 to 180 Hz while females range from 165 to 250 Hz. The amplitude of the overtones can be affected by manipulating the diameter of resonating chambers (i.e. the mouth).

The human vocal cords are similar to the operation of a bottle whistle, also known as a Helmholtz resonator. As air is blown over the opening of a bottle, it is forced into the empty bottle, creating a pressure gradient. The system responds like a spring, with air being pushed back out of the bottle, causing the pressure inside the bottle to decrease. Air from outside then rushes back into the bottle and the process is repeated. Thus, the air will oscillate in and out of the container at some natural frequency. If air is gently blown over the opening, the sound that is produced is primarily due to the fundamental frequency of the resonating cavity.

Practice Passage

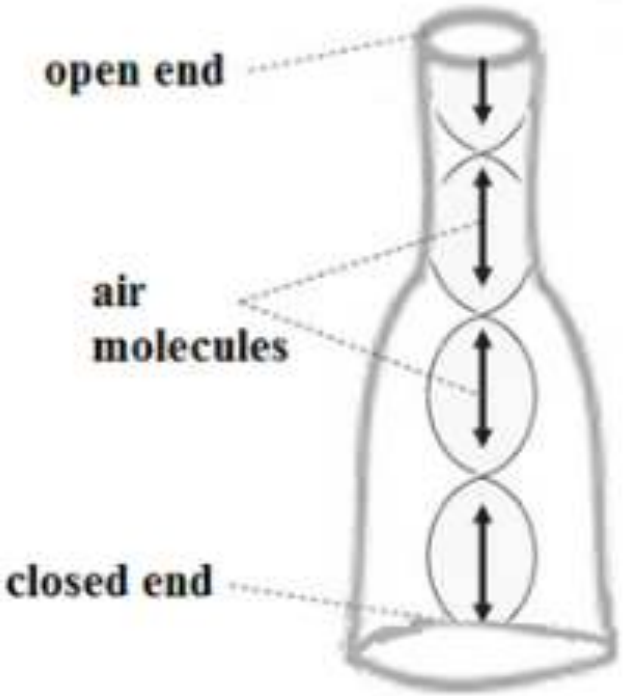


Figure 1 Bottle whistle.

Blowing air more forcefully can result in the production of one or more overtones. The pitch of the fundamental frequency can be changed by adding water to the bottle. Equation 1 allows for the calculation of the fundamental frequency of a bottle.

$$f = \frac{v}{2\pi}\sqrt{\frac{A}{VL}}$$

Equation 1

Practice Passa

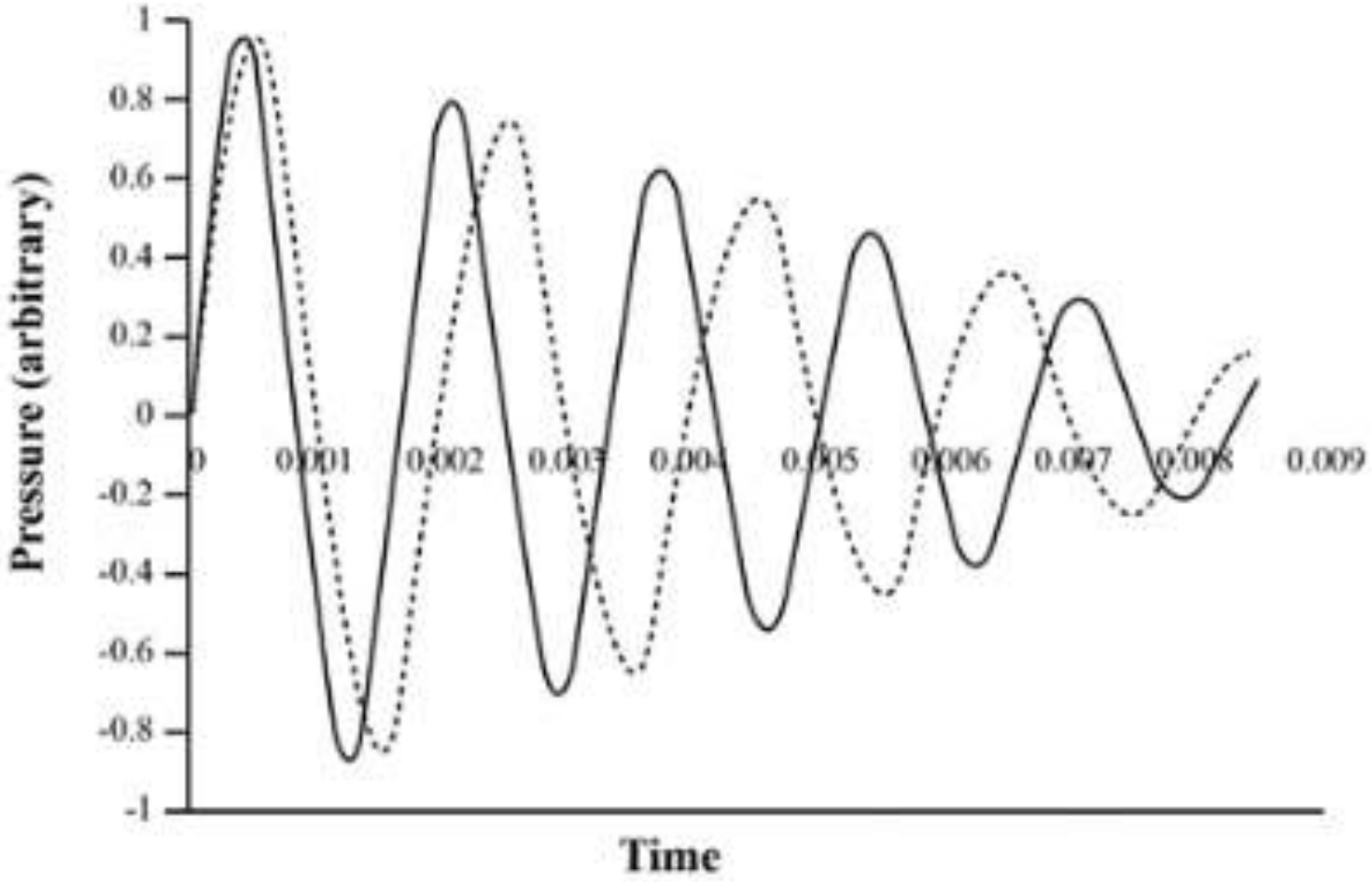


Figure 2 Pressure versus time for two bottles (F1 = solid line and F2 = dashed line)

(Note: Velocity of sound in air = 343 m/s)

Practice Passage

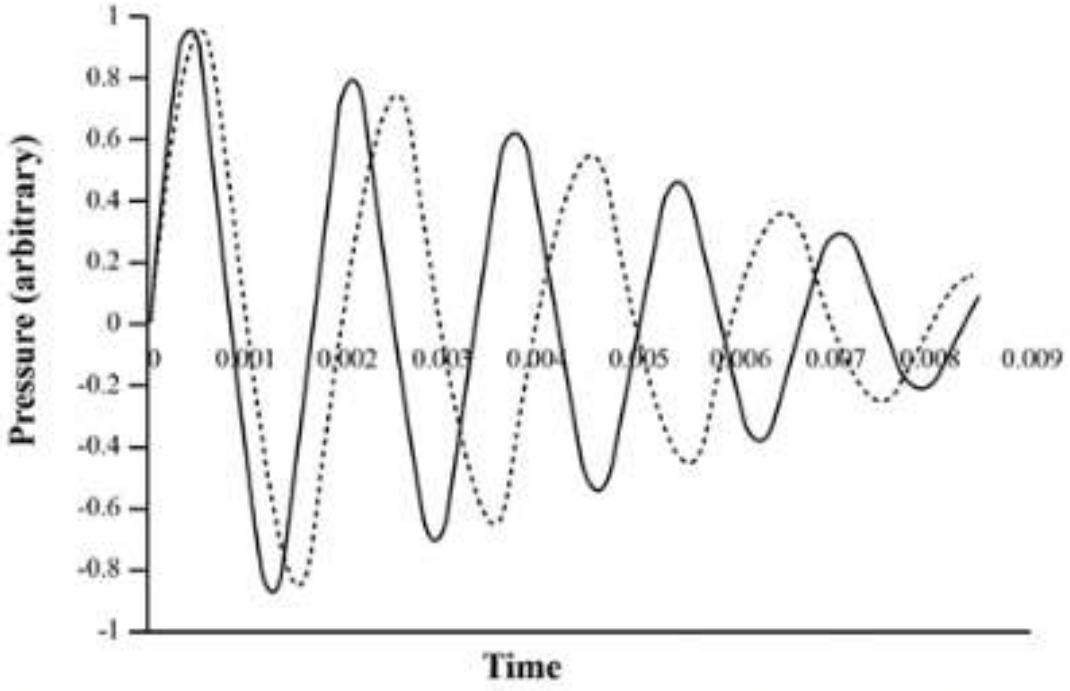
What is the frequency of the lowest pitched tone produced by the bottle whistle in Figure 2?

A. 500 Hz

B. 600 Hz

C. 1000 Hz

D. 1200 Hz



Practice Passage

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According to the passage, what is the predicted fundamental wavelength of the average human vocal cords?

A. 20 cm

B. 40 cm

C. 80 cm

D. 100 cm

Practice Passage

Which of the following describe the number of nodes and antinodes for a closed tube resonator?

I. For the fundamental, there is a single node and a single antinode.
II. For the third harmonic, there are two nodes and two antinodes.
III. For the fifth harmonic, there are three nodes and three antinodes.The pitches get higher and the loudness stays the same

A. I only

B. I and III only

C. II and III only

D. I, II, and III

Practice Passage

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Which of the expressions below correctly shows the relationship between the pressure inside and outside of the bottle when the person is blowing over the mouth of a bottle filled with air?

A. Pressure inside < Pressure outside

B. 2(Pressure inside) = Pressure outside

C. Pressure inside > Pressure outside

D. Pressure inside = Pressure outside

This is fluid dynamics!

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Q&A

Next Step: Core Values

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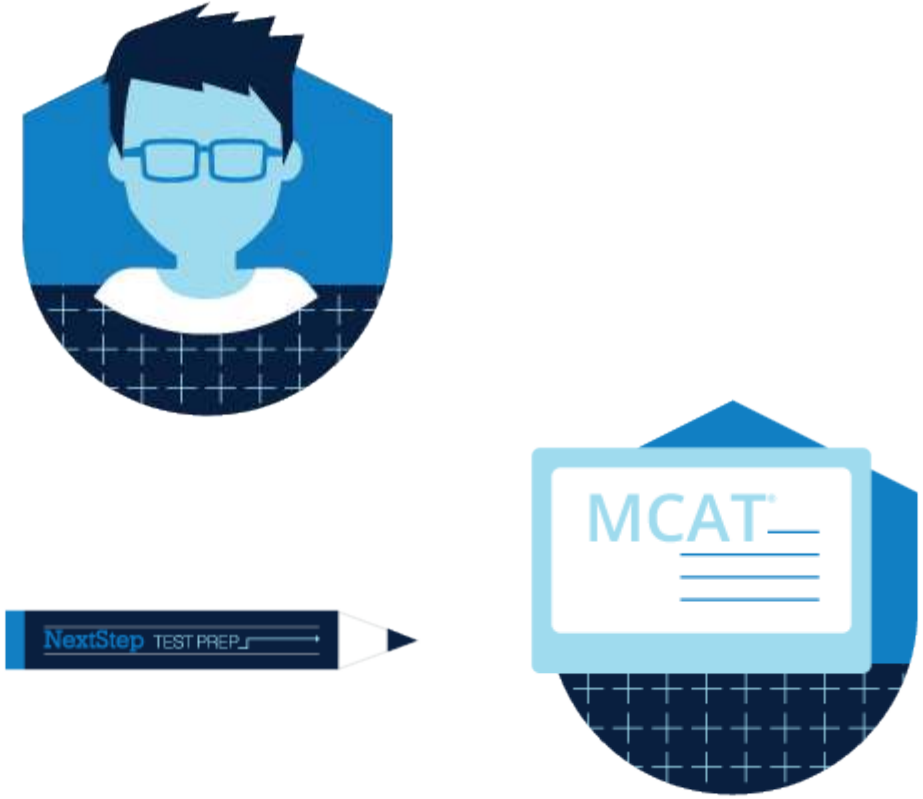

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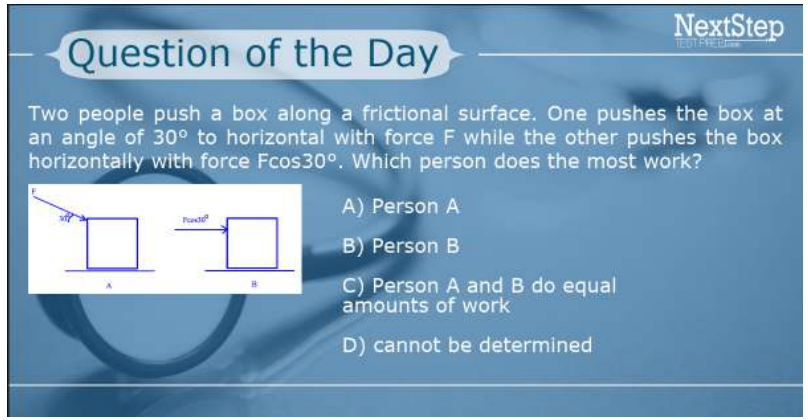
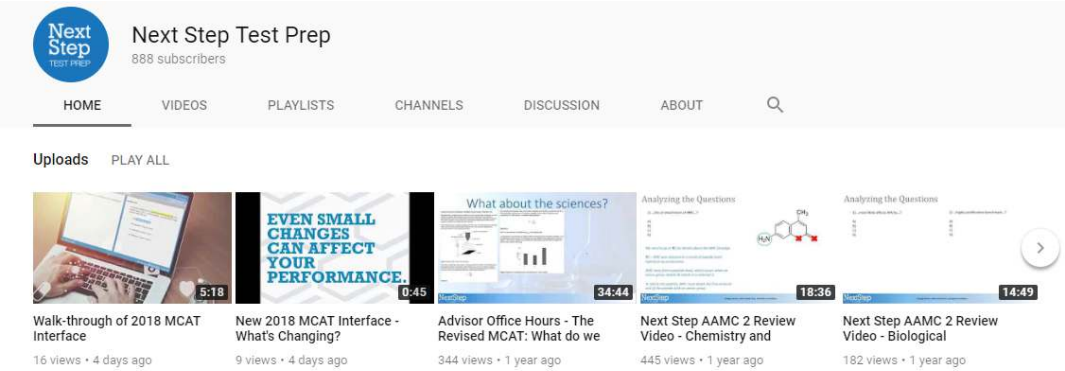


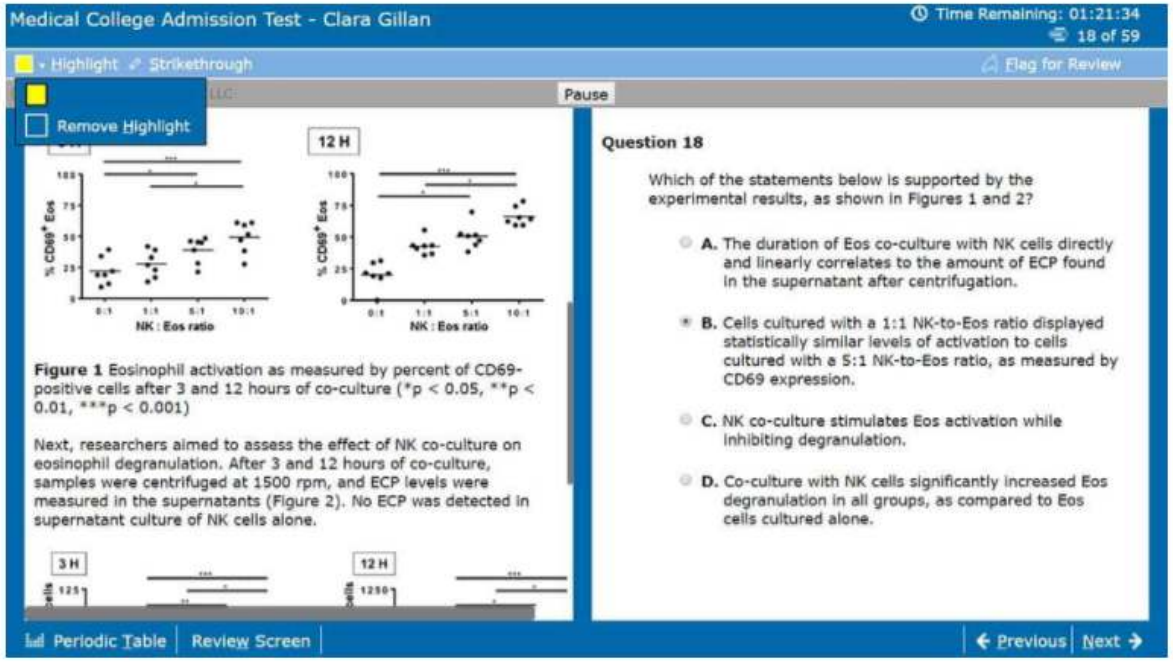


New 2018 MCAT Interface

Next Step TEST PREP

- New highlighting features
- New strikethrough features
- New keyboard shortcuts
- New Navigation/Review Screens

Next Step is ready. Are you?



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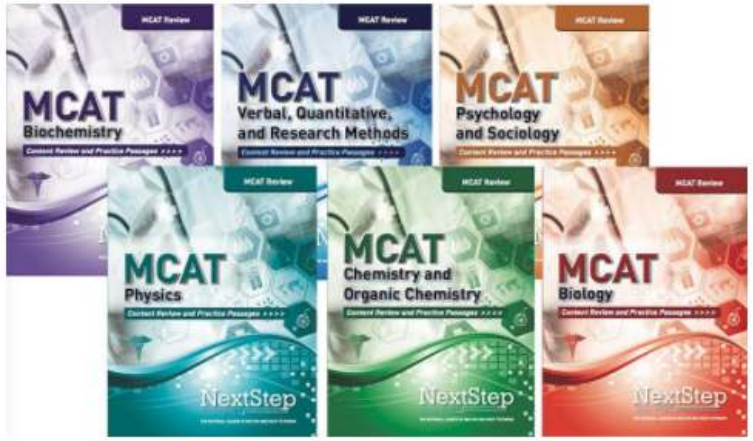

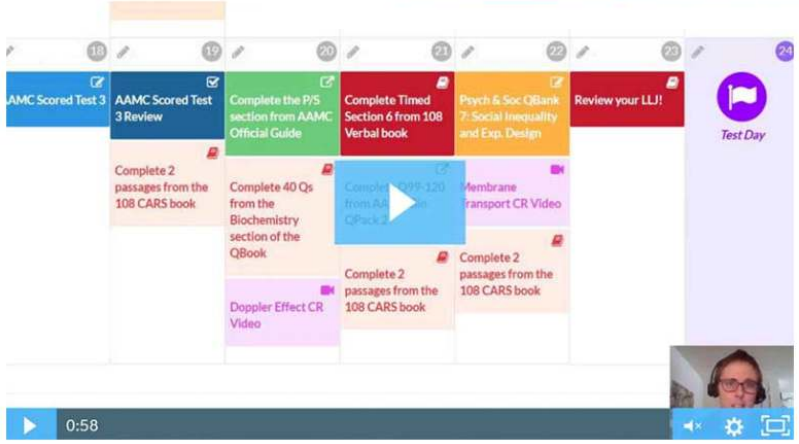

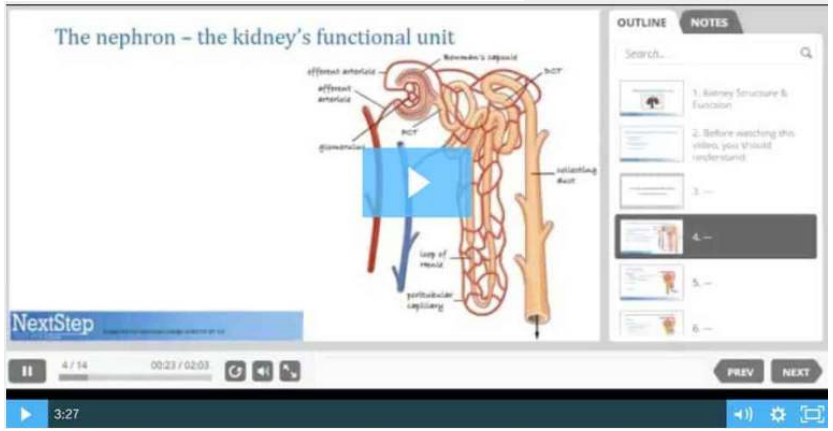

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✓ **All aligned to new 2018 interface**

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Electricity and Magnetism

$F = kQ_1Q_2 / r^2$

$F = qVB\sin\theta$

$F = iLB\sin\theta$

$V = IR$

$P = IV$

$R = \rho L / A$

$V_{rms} = V_{max} / \sqrt{2}$

$I_{rms} = I_{max} / \sqrt{2}$

Resistors in series:

$R_{tot} = R_1 + R_2 \ldots$

Resistors in parallel:

$1/R_{tot} = 1/R_1 + 1/R_2 \ldots$

Capacitors in series:

$1/C_{tot} = 1/C_1 + 1/C_2 \ldots$

Capacitors in parallel:

$C_{tot} = C_1 + C_2 \ldots$

$C = Q/V$

$\text{Energy} = (1/2)QV$

$F = qE$

$V = Ed$

$\text{Energy} = qEd$

$E = kQ/r^2$

$\text{Energy} = kQq/r$

$V = kQ/r$

$\Delta G = -nFE$

$E_{cell} = E_{cath} - E_{an}$

Waves

$v = f\lambda$

$T = 1/f$

Light

$n_1\sin\theta_1 = n_2\sin\theta_2$

$\sin\theta_c = n_2/n_1$

$E = hf$

$m = -d_i / d_o$

$P = 1/f$

$f = (1/2)r$

$n = c/v$

$1/f = 1/d_i + 1/d_o$

Sound

$d\beta = 10 \log (I/I_o)$

$L = n\lambda/2$ (n=1, 2…)

$L = n\lambda/4$ (n=1,3…)

$f_{beat} = |f_1 - f_2|$

$f = f_e[v \pm v_d]/[v \pm v_s]$

Fluids

$\rho = m/V$

$P = F/A$

$P = P_{atm} + \rho gd$

$F_b = \rho gV$

$Q = Av$

$P + \rho gy + (1/2)\rho v^2 = \text{constant}$

Gases

$PV = nRT$

Boyle: $PV = k$

Guy-Lussac: $P/T=k$

Charles: $V/T=k$

Avogadro: $n/V=k$

$R_1/R_2=\sqrt{(m_2/m_1)}$

$P_A = X_A \times P_{tot}$

Solutions

$pH=pK_a+\log (A^-/HA)$

$M = \text{mol} / L$

$m = \text{mol} / \text{kg}$

$N = M \times \#\text{ of } H^+$

$pH = -\log [H^+]$

$M_iV_i = M_fV_f$

$\Pi = MRT$

$\Delta T_f = ik_fm$

$\Delta T_b = ik_bm$

$X_A = \text{mol}_A / \text{mol}_{tot}$

Thermo

$\Delta U = Q - W$

$\Delta U = (3/2)nRT$

$W = P\Delta V$

$Q = mc\Delta T$

$Q = mH_L$

$\Delta G = \Delta H - T\Delta S$

$\Delta H_{rxn} = \Delta H_{prod} - \Delta H_{react}$

Kinematics

$v_f = v_o + at$

$d = v_ot + (1/2)at^2$

$v_f^2 = v_o^2 + 2ad$

$a_c = v^2 / r$

$F_c = mv^2 / r$

$v_x = v_o\cos\theta$

$v_y = v_o\sin\theta$

Mechanics

$F = ma$

$F_{a\ on\ b} = -F_{b\ on\ a}$

$F_{fric} = \mu F_N$

$F_g = GM_1m_2 / r^2$

$F_g = mg$

$F = kx$

$\tau = rF\sin\theta$

$P = W/t$

$W = Fd\cos\theta$

$E_K = (1/2)mv^2$

$U = mgh$

$U = -GM_1m_2 / r$

Inclined Plane

$F_{incline} = mg\sin\theta$

$F_N = mg\cos\theta$

$F_{fric} = \mu mg\cos\theta$