How to deal with Equations on the MCAT

Today's Info Session

- Introduction
- Overall equations
  - Tips for the math
  - Electrostatics
  - Magnetism
- How Can Next Step Help?
  - Coupon for $300 off the course!
- Questions?

Next Step TEST PREP

MCAT
Medical College Admission Test

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!

Math on the MCAT

Chemistry and Physics

Bio

- Hardy Weinberg
- Recombination frequencies
- Enzyme rates
- IC_{50}
- DATA!!!!!

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:

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

$C = Q/V$

$Energy = (1/2)QV$

$F = qE$

$V = Ed$

$Energy = qEd$

$E = kQ/r^2$

$Energy = kQq/r$

$V = kQ/r$

$\Delta G = -nFE$

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

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

$\rho = m/V$

$P = F/A$

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

$F_b = \rho gV$

$Q = Av$

$P + \rho gy + (1/2)\rho v^2 =$ 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

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

$M = mol / L$

$m = mol / kg$

$N = M \times \#\ of\ H^+$

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

$M_iV_i = M_fV_f$

$\Pi = MRT$

$\Delta T_f = ik_fm$

$\Delta T_b = ik_bm$

$X_A = mol_A / mol_{tot}$

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

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

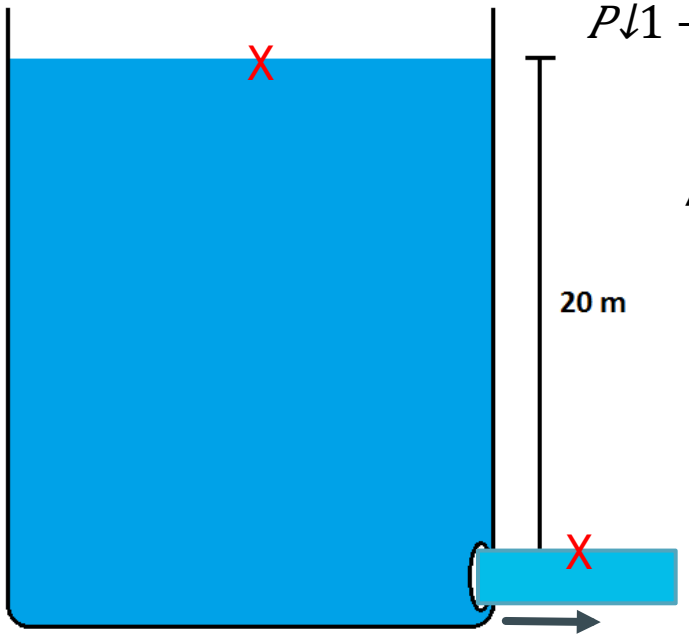
$F_N = mg\cos\theta$

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

Tip #1-

Look for stuff to cancel and avoid plugging in numbers and calculating until the very end.

How fast will water spray from this container if a hole is drilled 20 m below the surface level?



$$P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2$$

$$P_1 + \rho g h_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho v_2^2$$

$$\rho g h_1 + \frac{1}{2}\rho (0)^2 = \rho g h_2 + \frac{1}{2}\rho v_2^2$$

$$\rho g h_1 = \rho g 0 + \frac{1}{2}\rho v_2^2$$

$$\rho g h_1 = \frac{1}{2}\rho v_2^2$$

$$g h_1 = \frac{1}{2} v_2^2$$

$$v_2^2 = 2 g h_1$$

$$v_2 = \sqrt{2 g h_1}$$

$$v_2 = \sqrt{2(10)(20)}$$

$$v_2 = \sqrt{400}$$

$$v_2 = 20\,m/s$$

This question is taken from the content review videos.

Tip #2- Let the answer choices help you.

Help you figure out how to solve an equation

Guide your rounding

What is the rate of flow for water traveling through a pipe that has a diameter of 4 cm and a length of 310 meters if the pressure change from one end of the pipe to the other is 90 kPa and the viscosity of water is 0.009 Pa s?

A. $2.0\ x\ 10\uparrow -3\ m\uparrow 3\ /s$
B. $4.0\ x\ 10\uparrow -3\ m\uparrow 3\ /s$
C. $6.3\ x\ 10\uparrow -3\ m\uparrow 3\ /s$
D. $9.0\ x\ 10\uparrow -3\ m\uparrow 3\ /s$

$$Q=\Delta P\pi r\uparrow 4\ /8\eta L$$

$$Q=(9\ x\ 10\uparrow 4\ \ Pa)(3.14)(0.02\ m)\uparrow 4\ /8(9\ x\ 10\uparrow -3\ \ Pa\ s)(3.1\ x$$

$$Q=(9)(3.14)(2)\uparrow 4\ /8(9)(3.1)$$

$$Q=16/8=2$$

Tip #2- Let the answer choices help you.

Help you figure out how to solve an equation

Guide your rounding

Bill pushes a 2 kg box with a force of 8N. If the box moves 3 meters over the course of 2 seconds, what is Bill's power?

A. 1.5 *Watts*
B. 8 *Watts*
C. 12 Watts
D. 16 Watts

A 6kg, +3C charge is placed 4 m from another point charge. The spot that is placed in has a potential of 8 volts. What is the magnitude of the force experienced by the charges?

Electrostatics

One of the four fundamental forces of physics:

- **Electromagnetism**
- **Gravity**
- **Strong Nuclear**
- **Weak Nuclear**

The last two aren't on the MCAT. YAY!

Electrostatics

Difference between electrostatics and magnetism

- **Electrostatics:**

Study of stationary charges

- **Magnetism:**

Moving charges

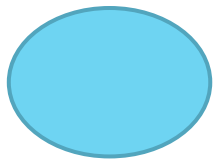
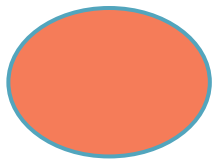
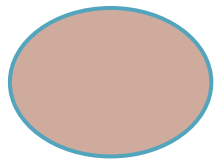
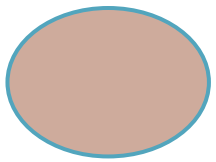
Electrostatics

Electrostatic Force:

F= kqQ/ r^2

Gravity!

F= GmM/ r^2

Electrostatics

Newtons!

Force:

F= kqQ/ r^2

Joules!

Energy:

U= kqQ/ r

Joules = Nm

Energy = Force x distance

Energy = (kqQ/ r^2) (r)

Electrostatics

Newtons!

Force:

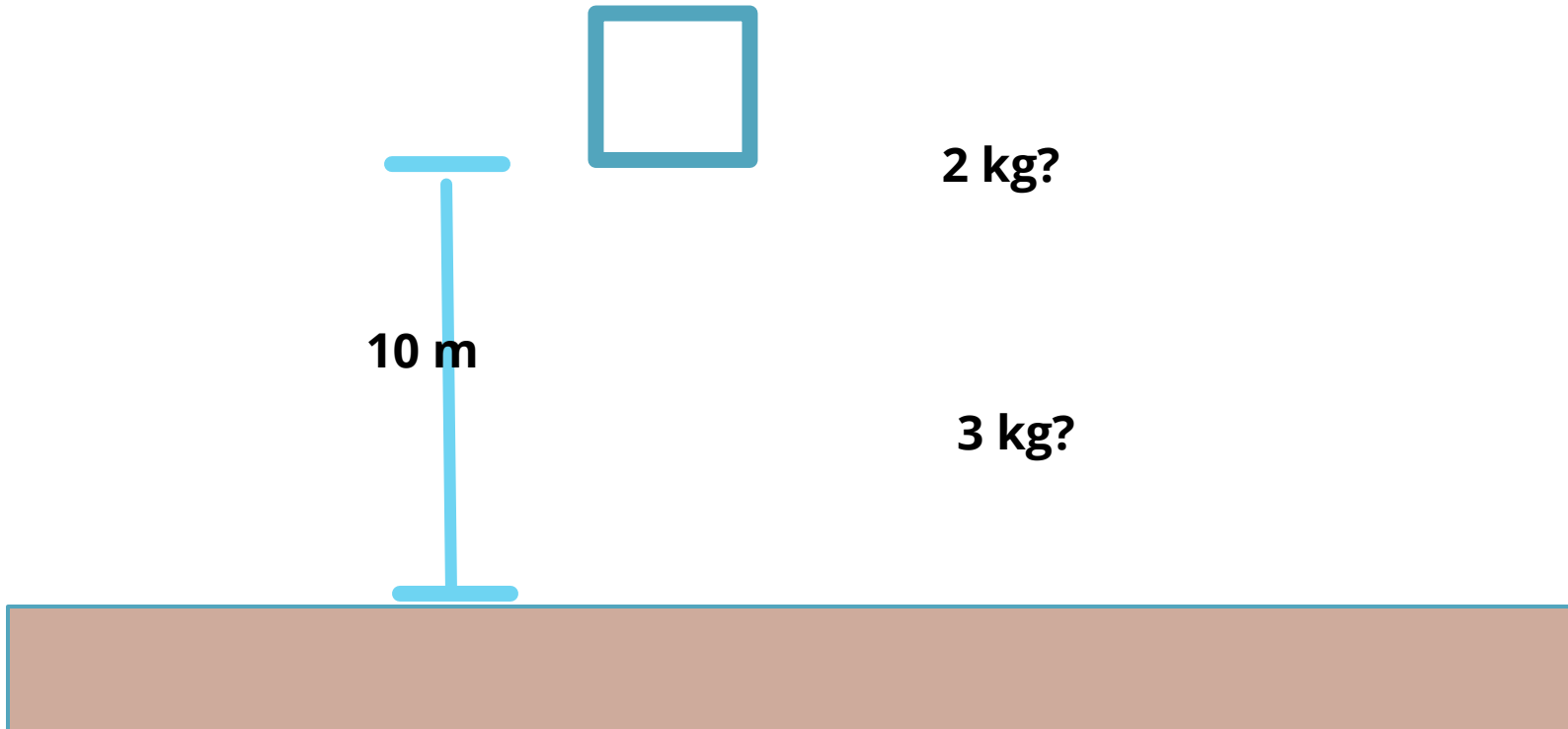
F= kqQ/ r^2

Joules!

Energy:

U= kqQ/ r

This spot is 10 m above the ground, How much energy will a 1 kg object have *if* I put it in the spot?



Electrostatics

Newtons

Force:

F= kqQ/ r^2

Joules

Energy:

U= kqQ/ r

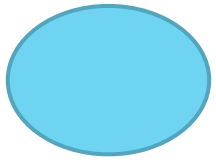
J/C

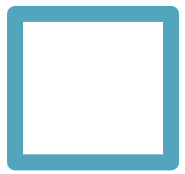
Potential

V= kq/ r

A single charge will create a voltage. If we put in another charge, it will have energy.

Voltage = Joules/Coulomb





Electrostatics

Newtons

Force:

F= kqQ/ r^2

N/C!

Electric field

E= kq/ r^2

Electric fields are similar to voltage, but are N/C

Joules

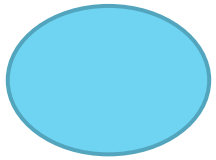
Energy:

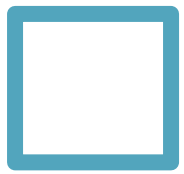
U= kqQ/ r

J/C

Potential

V= kq/ r





Electrostatics

Force:

F= kqQ/ r^2

Electric field

E= kq/ r^2

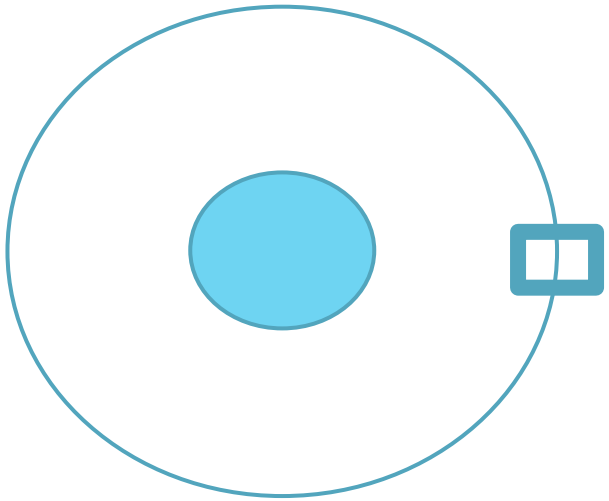
Energy:

U= kqQ/ r

Voltage

V= kq/ r

U= Fr
V=Er
U=qV
F=qE



2m from a positive charge, there is a voltage of 30 Volts. How much energy will a 2C charge have if I place it there?

How much energy if I put a 3C charge at 4m?

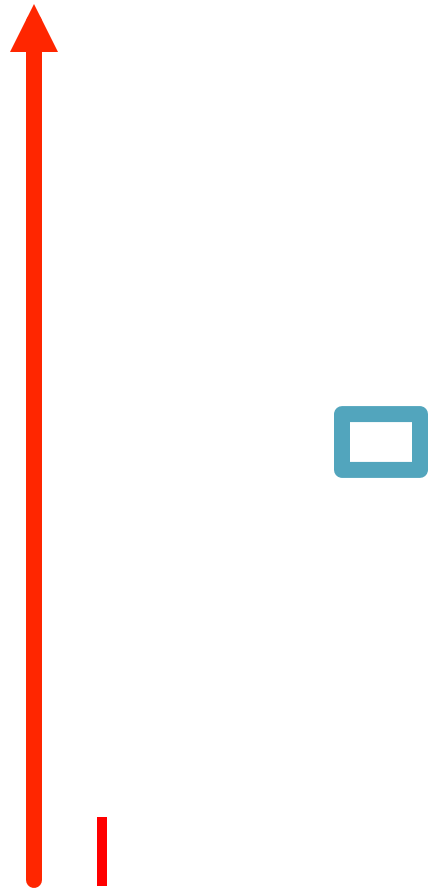
How much force will there be if I place a 6 C charge at 6m?

Magnetism

Magnetic fields are created by moving charges and exert forces on other moving charges.

$B = \mu I / 2\pi r$

$\mu = 1.256 \times 10^{-6}\ N/A^2$

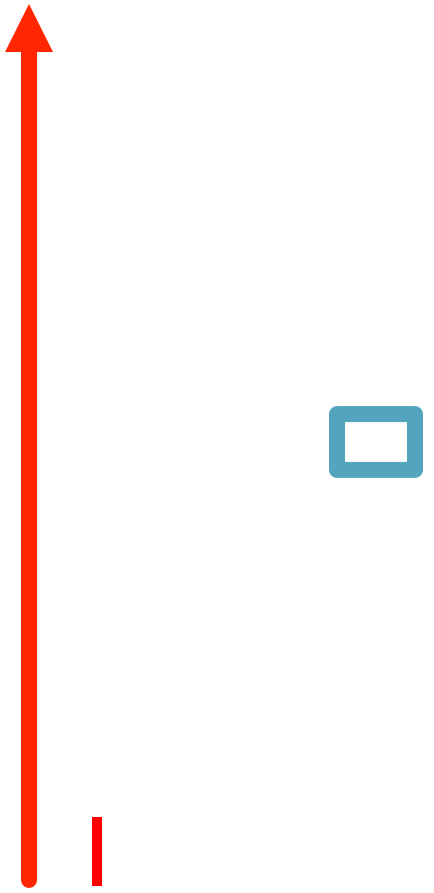


Magnetism

Right-hand-rule #1

Thumb = direction of current

Fingers = curl with magnetic field (which is circular)



Magnetism

Right-hand-rule #1

Thumb = direction of current

Fingers = curl with magnetic field (which is circular)

Magnetism

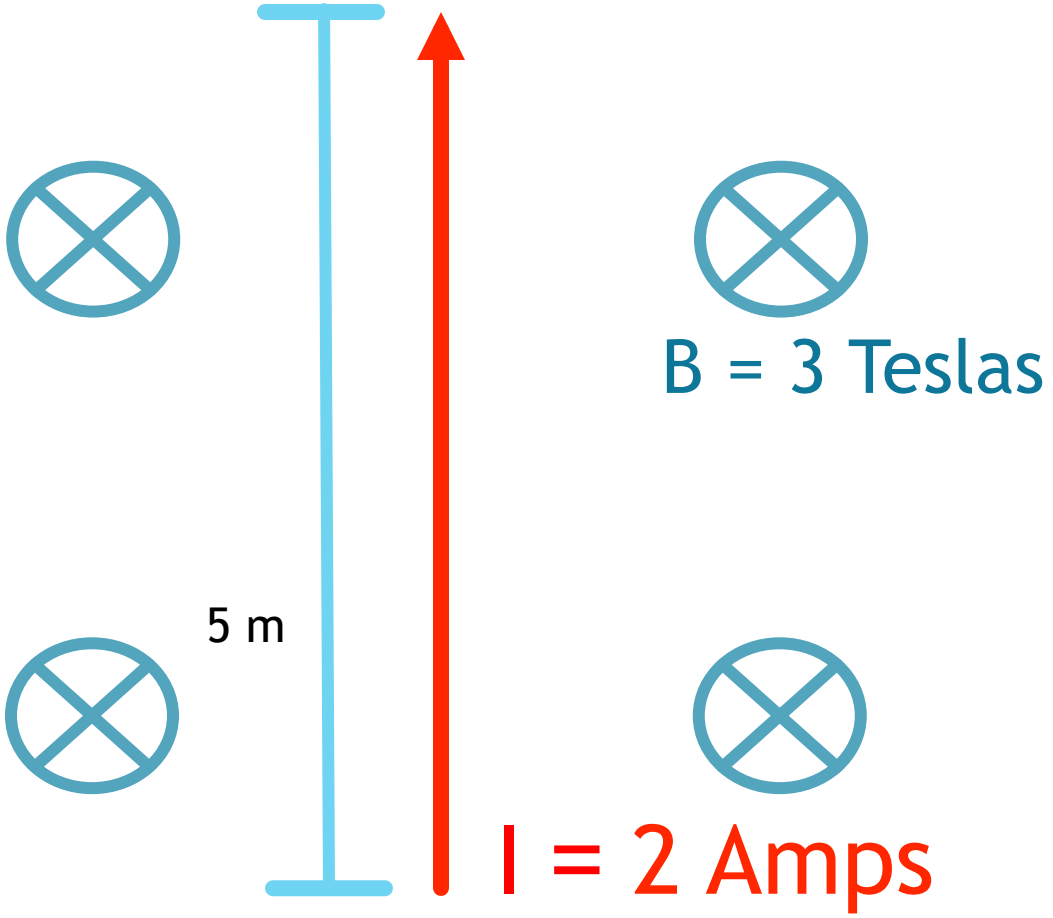
Magnetic fields exert forces on other moving charges. These moving charges could be :

Particles (like a proton)

F = qvBsin theta

Current carrying wires

F = ILBsin theta



Magnetism

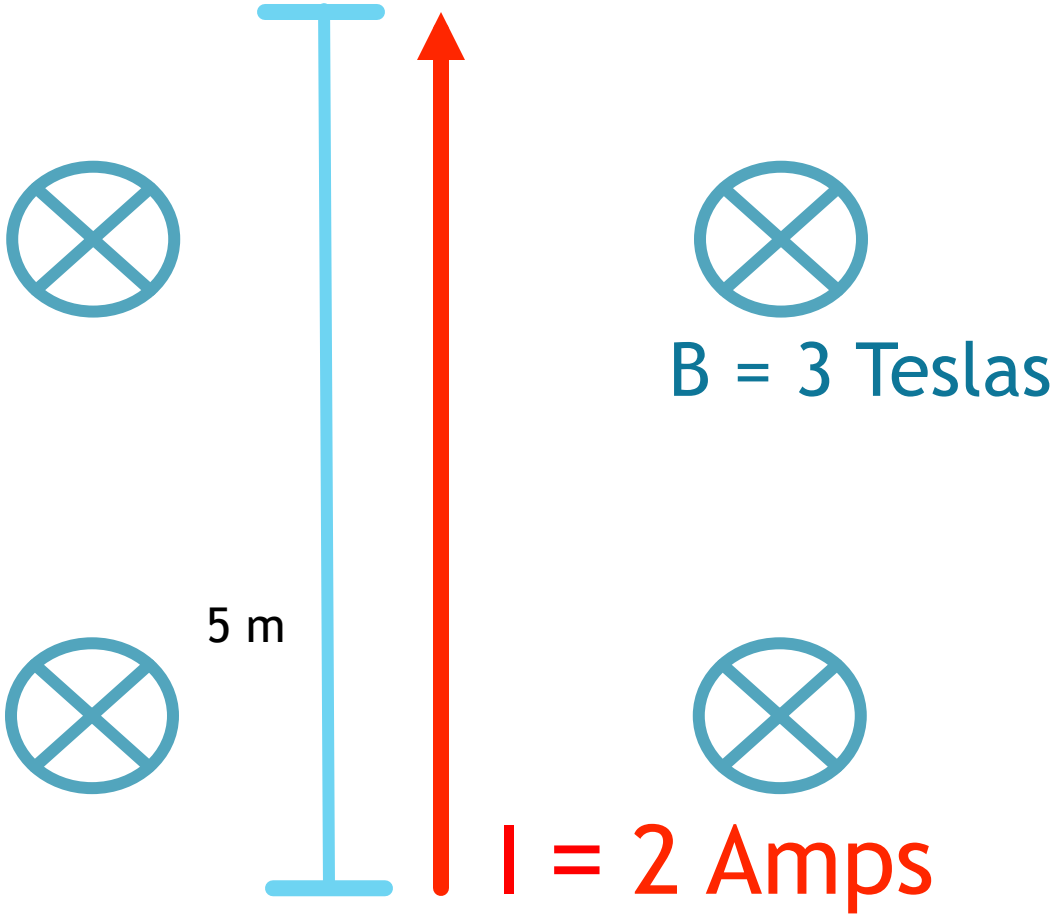
What about direction?

Right-hand-rule #2

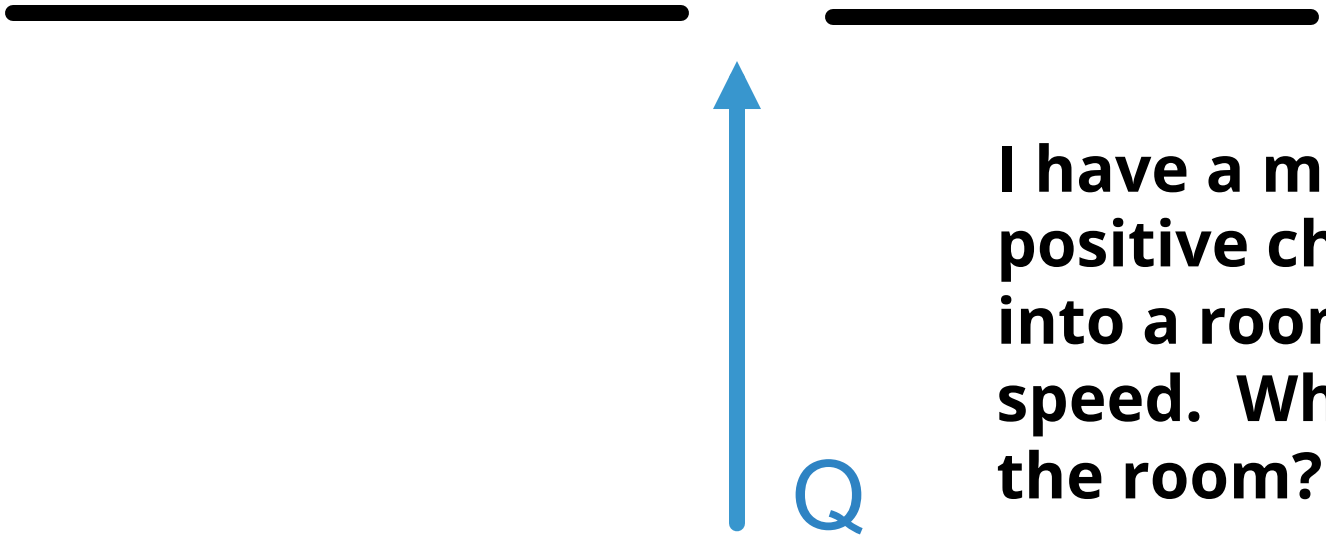
Thumb = direction of velocity/ Current

Fingers = direction of B

Palm = direction of force



Magnetism



I have a machine that gives molecules a positive charge and then shoots them into a room with a magnetic field at a set speed. What happens as I fire them into the room?

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Q&A

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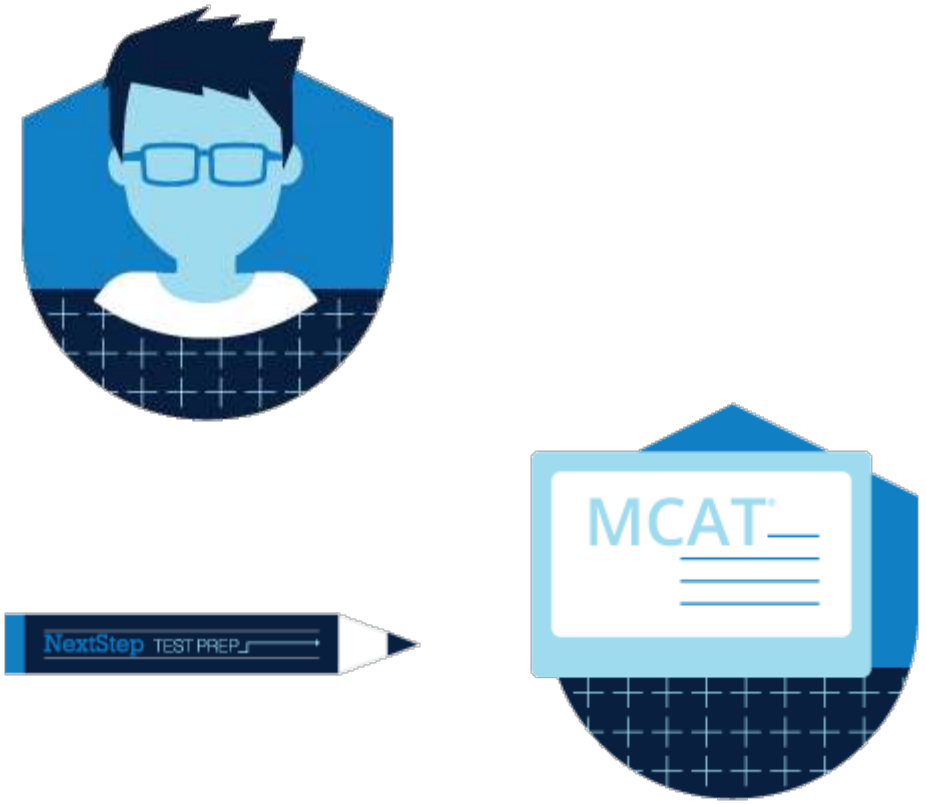

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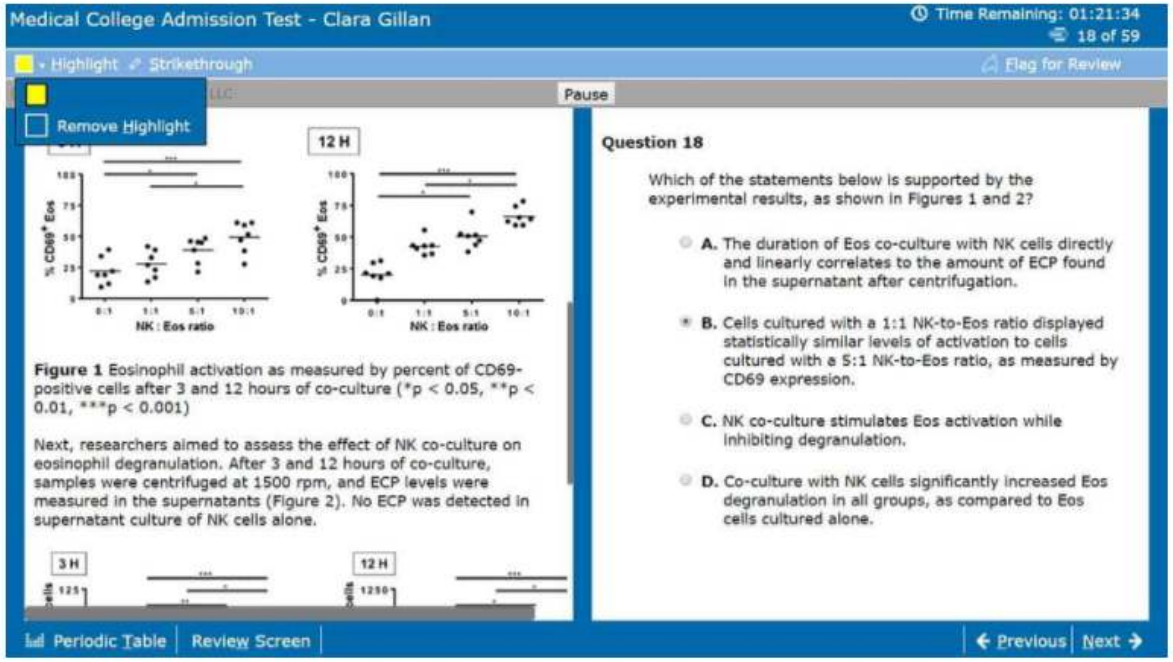

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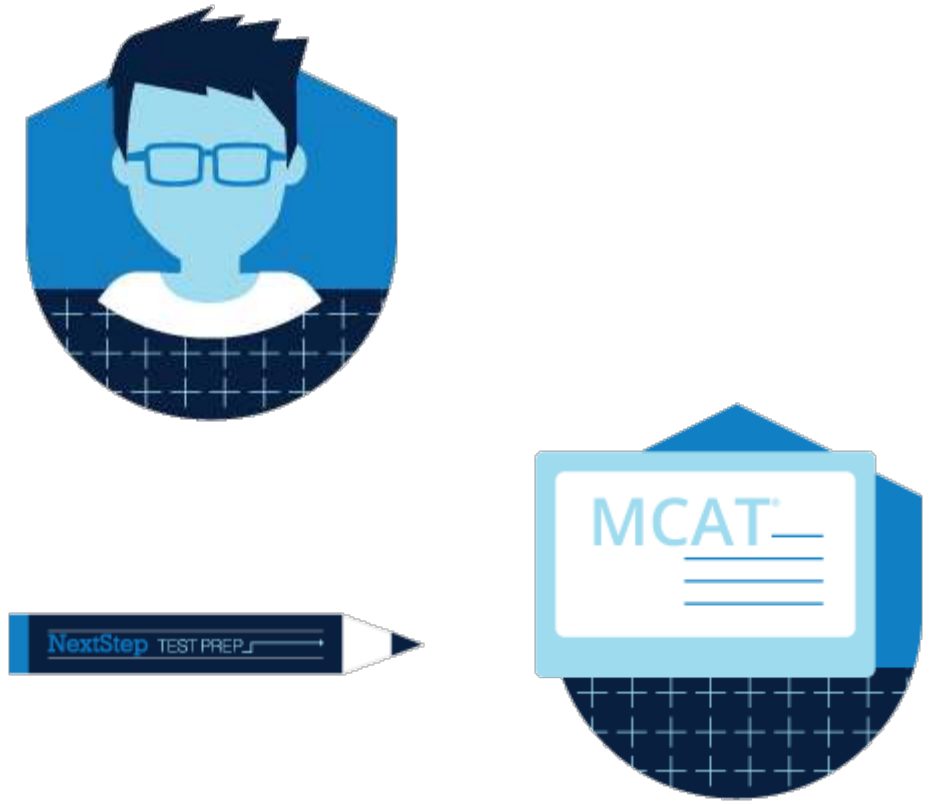

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