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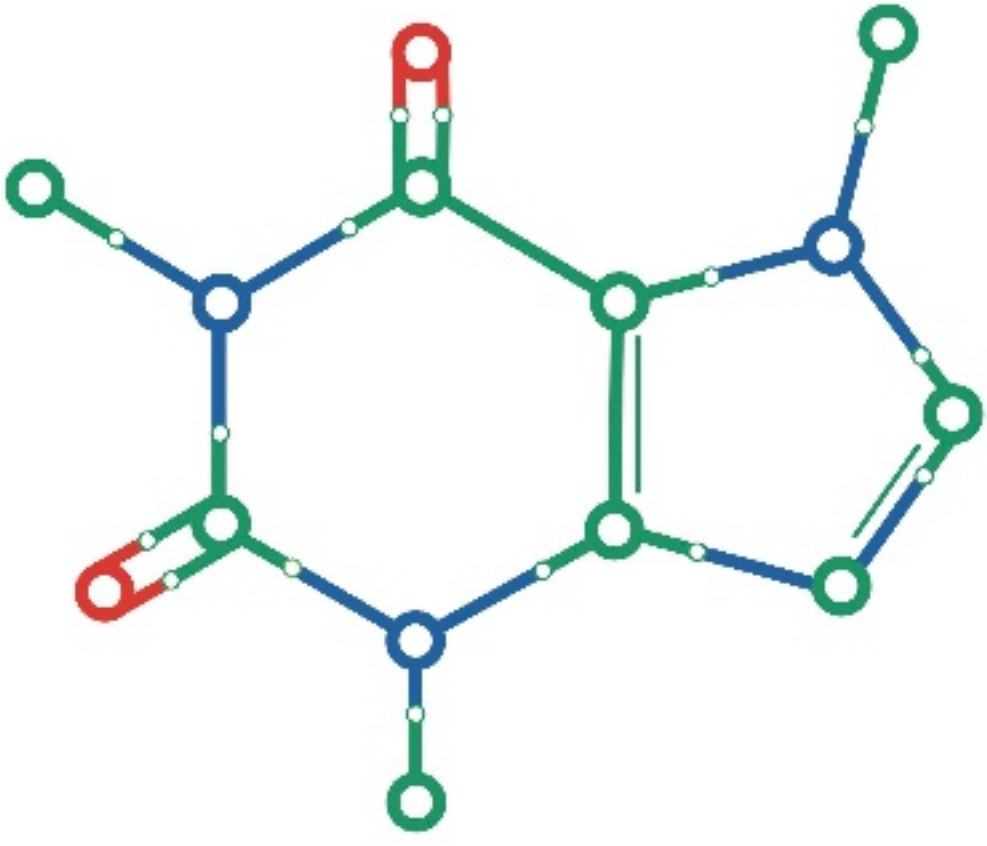
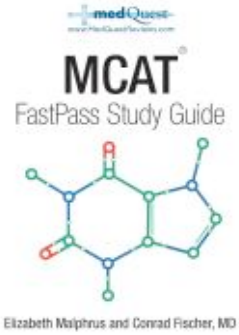
FastPass Study Guide



Elizabeth Malphrus and Conrad Fischer, MD



Keep your studying focused and high-yield with the ultimate MCAT study guide. This comprehensive guide includes all of the most important facts, figures, formulas, and concepts you need to master the new MCAT in a single, accessible volume. Use it to guide your study sessions so you focus on what's most important, quickly find the information you need, and keep track of what you've covered.

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MCAT® FastPass
Study Guide

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PART I:
CHEMICAL AND PHYSICAL FOUNDATIONS OF BIOLOGICAL SYSTEMS

Physical Properties of Matter

SI Unit Prefixes	
Tera-	10^{12}
Giga-	10^{9}
Mega-	10^{6}
Kilo-	10^{3}
Hecto-	10^{2}
Deka-	10^{1}
Deci-	10^{-1}
Centi-	10^{-2}
Milli-	10^{-3}
Micro-	10^{-6}
Nano-	10^{-9}
Pico-	10^{-12}

- **Translational motion** is the movement of objects from one point in space to another.
  - **Speed** = distance/time (units: m/s)
  - **Scalar vs. vector:** Scalar quantities have magnitude, but no direction (speed, mass, time, volume, temperature, friction). Vector quantities have magnitude and direction (velocity, displacement, acceleration, force).
  - **Acceleration** is change in speed over time (m/s^2).
- **Periodic motion** describes the movement of waves.
  - **Velocity** = frequency * wavelength ($v=f\lambda$)
  - **Amplitude** is one half the distance from the crest to the trough.
  - **Wavelength** is the distance from peak to peak, or trough to trough.
  - **Frequency** is the number of wavelengths per unit time.
  - **Period** is the time it takes for one wavelength to occur, or the inverse of the frequency (period = 1/f).
  - **Transverse vs longitudinal waves:** In transverse waves, particles vibrate up and down in space, perpendicular to propagation of the wave (light, strings). In longitudinal waves, particles move back and forth in space, parallel to propagation of the wave (sound, springs).
- **Force** is an interaction that causes a mass to accelerate or deform.
  - Force = mass * acceleration (unit: Newton = $kg*m/s^2$).
  - **Newton's 1st Law** (inertia): An object at rest stays at rest and an object in motion stays in motion, unless acted on by an external force.
  - **Newton's 2nd Law:** The vector sum of forces on an object is equal to the mass of the object multiplied by the acceleration ($F_{net}=ma$).
  - **Newton's 3rd Law:** When one object applies a force to a second object, the second object exerts an equal and opposite force on the first object.
  - **Static vs. kinetic friction:** Static friction is what resists a stationary object starting to move. Kinetic friction is what resists the motion of an object that is already moving.
    - Static friction is always higher than kinetic for the same materials, because it is harder to start an object moving than to keep it moving.

- **Center of mass** is used to simplify modeling of multiple forces acting on an object. An object's center of mass is the point where it could be balanced on your fingertip (ex: A pencil balances at a point halfway between the two ends, but a hammer would balance at a point much closer to the head).
- **Conservative force:** When the work done by a force is independent of the path taken. (ex: Gravity is conservative; gravity is doing the same work whether an object falls straight down or at an angle. Friction is non-conservative; if you push a box in a straight line, friction does a lot less work than if you were to push a box in a curvy path to the same end point.)

□ **Equilibrium:** When the sum of forces acting on an object is zero, it remains at rest or at constant speed. Equilibrium in physics means the object has an acceleration of 0 m/s^2.

- **Vector analysis:** To determine net force acting on an object, add the vectors.

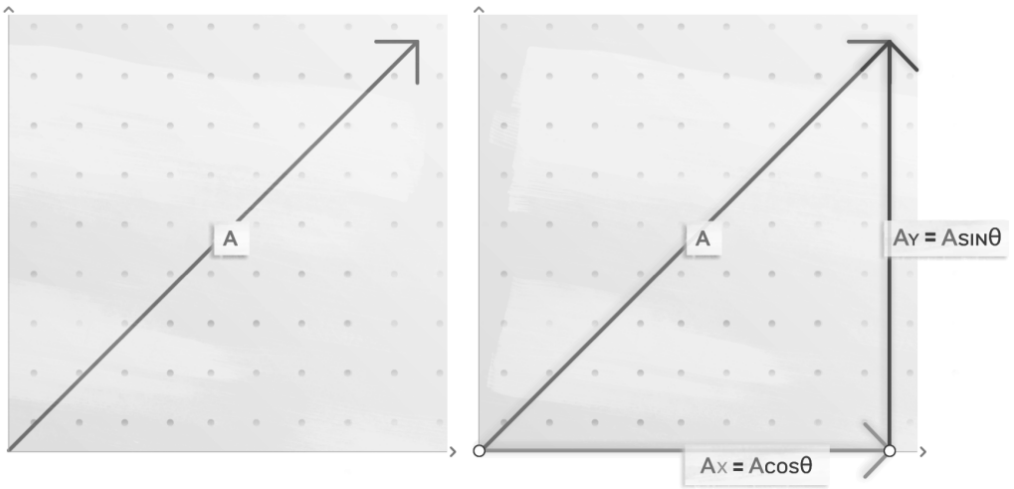


***Figure 1**: Vector addition approach 1.*

- **Vector addition approach 1:** Break any diagonal forces into x and y components. Sum all the x components, sum all the y components. Hypotenuse is the resultant force vector ($A = \sqrt{A_y^2 + A_x^2}$).
- **Vector addition approach 2:** Put vectors tip to tail. Resultant is the distance between the start of the first vector and the end of the last vector.

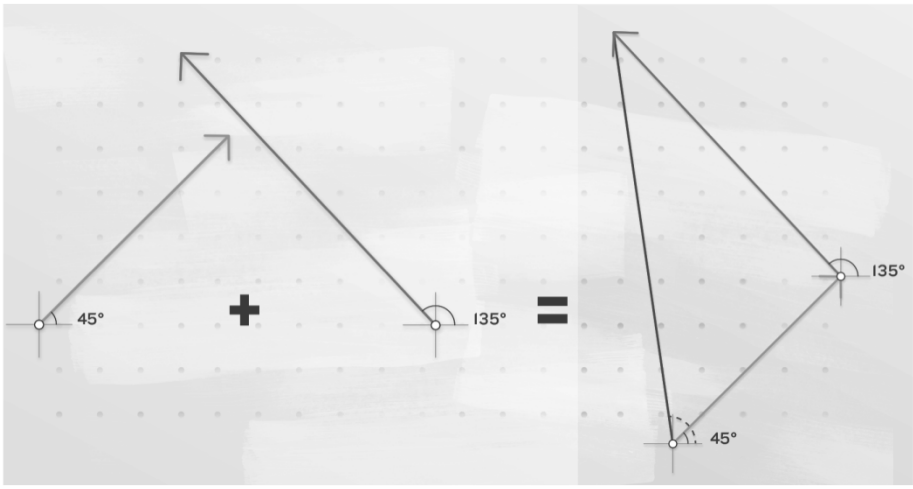
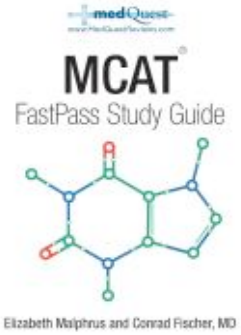


Figure 2: *Vector addition approach 2.*

- **Torque** is a force that causes an object to rotate some distance around an axis or pivot point (units: Joules = N*m, or $kg*m^2/s^2$).
  - *MCAT application: muscle moving bone.*
  - Torque = force * distance to fulcrum, or force * lever length
  - Torque = radius * force * sin(theta)
  - As the length of the lever arm increases, the force needed decreases, but the distance that the lever arm must be moved increases. (ex: That's why we put door knobs on the far side of doors, instead of in the center. It takes less force to open them that way.)
  - $W = F*d*\cos\Theta$
  - **Mechanical advantage** is the difference between the force needed to do work if you use a tool (lever or pulley), and the force needed to do work without the tool.
- **Kinetic and Potential Energy:** energy due to motion (kinetic) or position (potential)
  - Units: Joules = N*m = $kg*m^2/s^2$

Relationship Between Physics Work and Energy Units

Force (mass*acceleration) = $kg*m/s^2$ = **Newton**
Torque (Force*distance) = $N*m = kg*m^2/s^2$ = **Joules**
Work (Force*distance) = $N*m = kg*m^2/s^2$ = **Joules**
Kinetic/potential energy (force*distance) = $N*m = kg*m^2/s^2$ = **Joules**
Power (work/time) = Joules/sec = $kg*m^2/s^3$ = **Watts**
Hydrostatic pressure (force/area) = $N/m^2 = kg/(m*s^2)$ = **Pascal**



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