Physics Midterm Review Packet
January 2010

This Packet is a Study Guide, not a replacement for studying from your notes, tests, quizzes, and textbook.

Midterm Date: Thursday, January 28th 8:15-10:15

Room:

Red Class: **Room 107**

Yellow Class: **Room 403**

Format: 50 multiple-choice questions (50 points)
Choose 5 out of 8 Part II questions (50 points)

Bring:

- #2 Pencils
- blue pen to circle scan-tron answers
- ruler
- protractor
- calculator.

1. **Physics Tool kit.** Chapter 2.
Know your scientific notation. For positive exponents, move the decimal point to the right the amount of spaces indicated. Ex: $3.4 \times 10^5 = 340000.$

For negative exponents, move the decimal point to the left the amount of spaces indicated: Ex. $6.7 \times 10^{-3} = .0067$

- Adding and subtracting exponents: convert one to make exponents the same, add numbers
- Multiplying exponents: multiply numbers, add exponents
- Dividing exponents: divide numbers, subtract exponents

Know significant digits

- All non-zero digits are significant 1.2 → 2 significant digits
- All trailing zeros after a decimal point are significant 1.00 → 3 sig. digits
- Zeroes between non-zero digits are significant 1004 → 4 sig. Digits
- Any zero with a decimal point to the right is significant 10. → 2 sig. Dig
100 → 1 sig. Dig.
  - All other zeroes are not significant

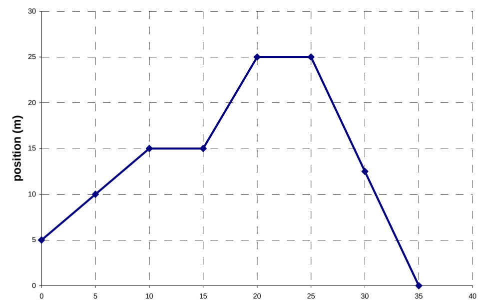
- Know the rules for mathematical operations with significant digits
- Addition-subtraction: round your answer to the least precise answer
- Multiplication-division: round your answer to the least number of significant digits you started with.

- Know the difference between a scalar and a vector.
  Scalar - magnitude only : 10 meters
  Vector - magnitude and direction: 10 meters north
- Don't forget the 10 steps:

1. Identify each **known** value given in the problem.
   1a. **convert** all values to SI units
2. Identify the **unknown** you are trying to find.
3. Write the **equation** that relates the known and the unknown values.
4. **Rearrange** the equation so that the unknown is isolated
5. **Substitute** the known values, including units, into the equation.
6. Solve Algebraically for the **units** of the answer.
7. **Calculate** the Answer.
8. **Convert** to the necessary units for the answer.
9. Check **Significant Digits**.
10. **Don't Forget units!**
    Remember, on this test, as well as the regents, **No unit = No answer**

Velocity Chapter 3

- Know all of the velocity formulas on the reference table
- Do not confuse average velocity (6), and change in velocity (ΔV)
- Do not confuse distance and dislacement (ΔS)
  Distance is how far travelled. A trip from my house to SHA and back is about 40 miles. Displacement is how far from the starting point. Going from my house to SHA and back will give me a displacement of 0
- Sign (+or-) indicates direction.
- The position-time graph
  - A **straight line** indicates **constant velocity**
  - The **Slope** is the velocity
  - Negative slope = negative direction = velocity in opposite direction.

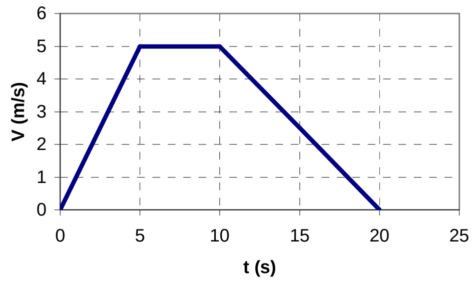


Common Mistakes to avoid:

- Forgetting to convert, i.e. from km/hr to m/s (multiply by 1000 and then divide by 3600)

Acceleration Chapter 4

- Acceleration is the **change** in velocity over time.
- The velocity-time graph
  - **Straight line** indicates **uniform** or **constant acceleration**
  - The **Slope** indicates the **acceleration**
  - A negative slope usually means deceleration or slowing down
  - **Area** under the graph indicates **displacement.**



Common mistakes to avoid:

- Forgetting to convert to SI units
- Leaving the ^{2} off of m/s^2
- Leaving the 1/2 of of 1/2bxh (area of a triangle)

Forces Chapter 5

Newton's Laws

1. An object with no net force on it remains at a constant velocity.
2. F=ma (really F_{net}= ma)
3. When one object exerts a force on a second object, the second object exerts a force on the first object of equal magnitude, in the opposite direction. Remember the two students on scooters trying to push only the other person? This law also explains why things laying on a table or the ground don't accelerate to the center of the earth.
   - The Normal force is the opposing force that a surface "pushes back" with
     - "Normal" means "perpendicular". The normal force is always perpendicular to the surface.

- Know the difference between mass and weight
  Mass is the amount of matter in an object. Weight is the force that pulls on the mass due to gravitational acceleration.
  - w=mg and f=ma are the same formula.

Mass can also be found by finding the force necessary to accelerate the mass at a given rate, like when you pushed my car across the parking lot.

- Friction
  - $F_f=\mu N$ the "fun formula"
  - μ = the coefficient of friction, the measure of what percentage of the normal force the frictional force is.
  - Direction is **always opposite to the direction of motion.**
    - Static vs. sliding friction

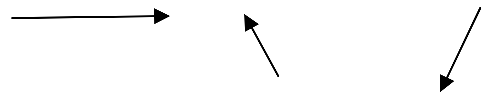
    Static friction is the friction that opposes the **start** of motion
    Sliding friction opposes **continued** motion
    - Sliding friction is always greater than sliding friction.

Vectors chapter 6

Graphically:

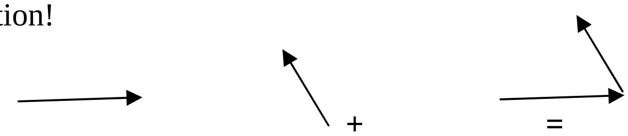
Vectors indicate **magnitude** (how much) and **direction** (which way)

- Vectors are drawn as arrows



Length indicates magnitude
Direction indicates…………Direction!

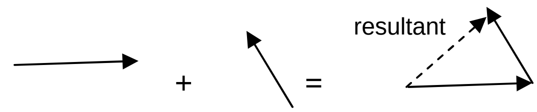
Addition is done **head to tail**



Vectors may be **moved** but **never rotated or changed in size**

The addition of any vector gives a **resultant** vector, which is a vector that represents the two or more **component vectors** that make up the **resultant.**

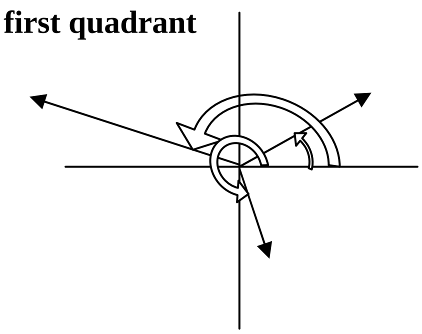
- The resultant is drawn from **start to finish**



Analytically:

Vectors in the same direction: add together
Vectors in opposite directions: subtract

- Direction is indicated in degrees, **always measured from the first quadrant**



Perpendicular vectors

- Perpendicular vectors are **independent of each other**

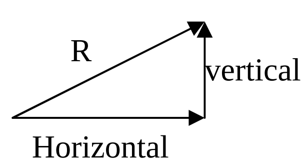
Addition:

- At right angles:
  - Magnitude: Pythagorean theorem ($a^2+b^2=c^2$)
  - Direction: from sohcahtoa, $\tan\theta = o/a$, $\theta = \tan^{-1}$
  - On your calculator: [2nd] [tan]

Vector resolution:

A vector may be **Resolved** or separated into horizontal and vertical components. This is the reverse of vector addition. Vector resolution is finding the vectors that add up to make a resultant.

Horizontal component: $R\cos\theta$
Vertical component: $R\sin\theta$
Don't mix them up, if you forget, they are on your reference table in the Motion ina Plane section.



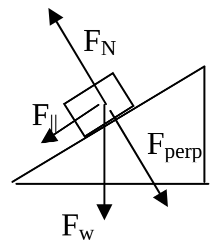
This is particularly useful for adding vectors at angles other than 0, 90, or 180 degrees

Vectors may be resolved into components the components added, leaving only horizontal and vertical vectors, which may be added with the pythagorean-tangent method.

Inclined planes

On an inclined plane the force of weight is resolved into parallel and perpendicular components.

- Normal Force is directed **perpendicular to the surface**



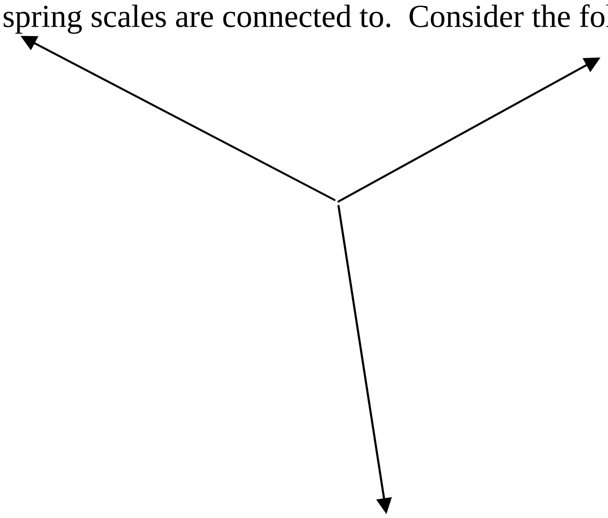
- $F_{||}$ is **always down the plane.**
- $F_N = F_{perp}$
- F_w is **always straight down.**

- Equilibrium is achieved on an inclined plane when the forces pushing up the ramp, be they applied or friction, are equal to the forces down the ramp. The box is then either at rest or moving with a *constant velocity.*

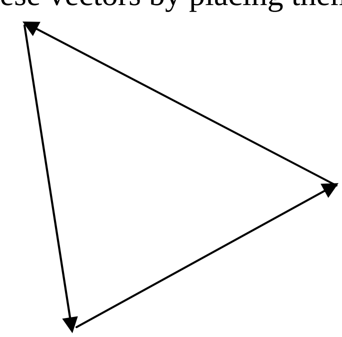
Equilibrium

- Equilibrium is achieved when **all forces add up to zero.**
- An object in equilibrium is **not accelerating.** It may be at rest or moving with a *constant velocity.*
- For any set of unbalanced forces there may be found an **equilibrant**, which is a single force that will bring the forces into equilibrium

When forces are in **equilibrium** there is no *net* force on the object that the force is applied to, and hence no acceleration. In this case, the object that forces are applied to is the ring that the spring scales are connected to. Consider the following three vectors:

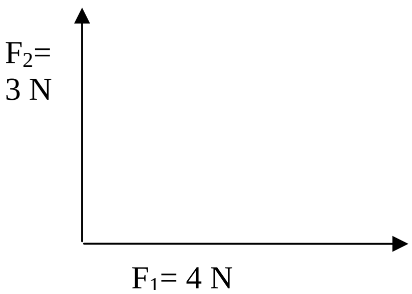


You may graphically add these vectors by placing them head-to-tail

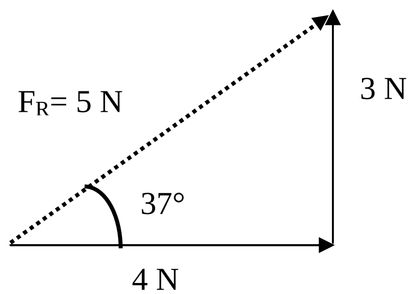


Note that when the vectors are added together, there is nothing "left over". There is no resultant force. These forces are in equilibrium, and may also be referred to as balanced forces.

For any set of unbalanced forces, a single force may be applied that will bring the system into equilibrium. This force is called the **equilibrant.** To find the equilibrant you must first find the resultant vector of the unbalanced forces. The equilibrant is the force that is equal and opposite to the resultant of all the other forces in the system. For example:

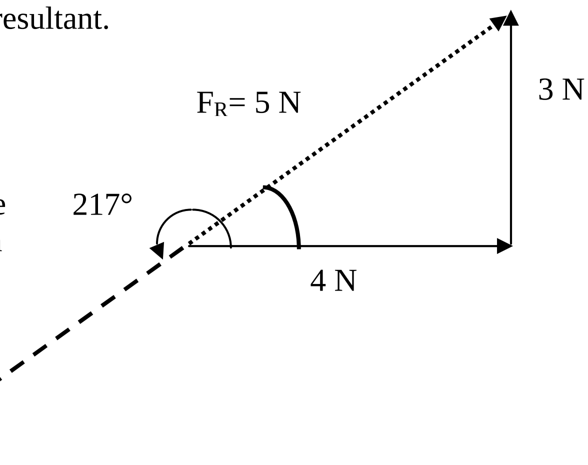


The two forces acting concurrently on an object will have a resultant force. This force may be found by adding the force vectors head-to-tail

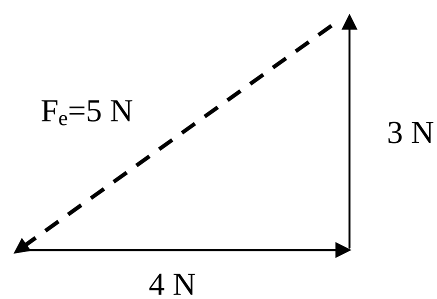


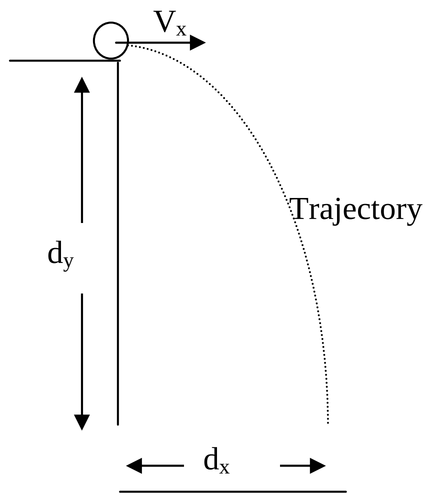
The equilibrant is the force that is equal in magnitude and opposite in direction to the resultant.

The direction of 217° is found by adding 180° to the resultant direction of 37°



Note that the addition of F_1, F_2, and F_e results in equilibrium.





Motion in a plane Chapter 7

Objects launched horizontally:

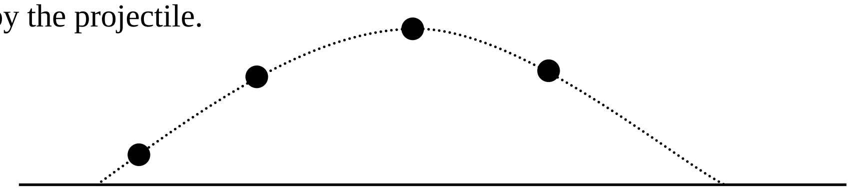
- $V_{ix}=V_{fx}$
- $V_{iy}=0$
- $a_x=0$

$$t=\sqrt{\frac{2d_y}{a_y}}$$

- $a_y=-9.8\ m/s^2$

- $d_x=V_{ix}t$
- Objects launched horizontally or dropped straight down will have the **same hang time** because the only factor that affects time in flight is **height** (d_y)
- The **range** is the horizontal displacement (d_x)
- The **Trajectory** is the path taken by the projectile.

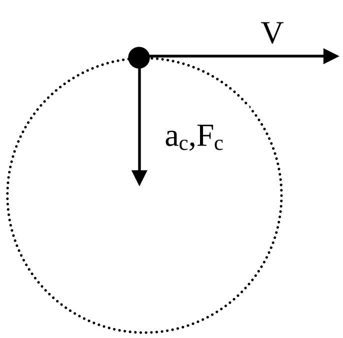
Objects launched at an angle:



$V_x=V_i\cos\theta$
$V_y=V_i\sin\theta$
$V_{fx}=V_{ix}$
Hang time: $t=\frac{-2v_{iy}}{a_y}$
Time up = half of t (half of the full trip)
Max height: $d_{ymax}=1/2\ a_yt^2+V_{iy}t$
Where t = half of the hang time and a = -9.8 m/s^2

- **Vertical acceleration** is always **downward**
- **Vertical velocity** is zero at the highest point of the trajectory (d_{ymax})
- **Horizontal acceleration** is always **zero**
- **Horizontal velocity is constant**

Uniform Circular Motion Chapter 7



- **Velocity** is directed tangent to the circular path
- **Centripetal** (center-seeking) **acceleration** is directed toward the **center of the circle**

- **Centripetal Force** is directed toward the **center of the circle**

$$v = \frac{2\pi r}{T}$$

The Period (T) is the time to make 1 complete revolution

Universal Gravitation Chapter 8

$$F = \frac{Gm_1 m2}{r^2}$$

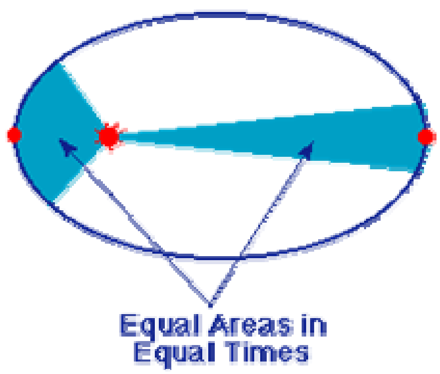
- Gravity is a force that acts between all objects, pulling them together
- The force of gravity is force that keeps planets and orbiting objects in their circular paths
- The relationship between **mass** and gravitational force is **direct**
- The relationship between **distance** and gravitational force is **inverse square**

Kepler's Laws

Kepler's three laws of planetary motions are:

1. The planets move in elliptical orbits with the Sun at one focus (and nothing at the other).
2. Any planet moves in such a way that a line drawn from the Sun to its center sweeps out equal areas in equal time intervals.
3. The ratio of the average distance from the Sun cubed to the period squared is the same constant value for all planets. That is:

$$r^3 = T^2$$



- According to Newton's laws of universal gravitation ($F = \frac{Gm_1 m_2}{r^2}$) and the circular motion formulas, The plane is moving **fastest when it is closest to the sun** and **slowest when it is furthest from the sun**
- Perihelion occurs in january
- The planets **kinetic energy** is highest when it is **closest** to the sun
- The planets **potential energy** is highest when it is **furthest** from the sun

The Reference Table

You will need the formulas in the mechanics section

You will need some of the values on the front page in the **List of physical constants** and the table of **approximate coefficients of friction.**

- G
- g
- Mass of the Earth
- Mass of the Moon
- Mean radius of the Earth
- Mean radius of the Moon
- Mean distance from the earth to the moon

- **Momentum and Impulse** chapter 9

Momentum is the product of **Mass** and **Velocity (p=mv).** An object with greater momentum will require more force to change its velocity. The unit of momentum is kg•m/s. (<u>not</u> kg•m/s^2)

- Momentum is a **vector quantity**

Impulse is the **change** in momentum (Δp) . an object that has a change in velocity will have a change in momentum. (mΔv). a rearrangement of newtons second law, F=ma, by substituting the definition of a (a=Δv/Δt) yields:. Impulse is then seen to be the force applied for an interval of time. Increasing the time of an objects acceleration (or deceleration) results in a decrease in force on the object, like when you throw an egg at a sheet, or decelerate your body against an airbag instead of the dashboard.

$$F = ma$$

$$F = m(\tfrac{\Delta V}{\Delta t})$$

$$F\Delta t = m\Delta v$$

$$impulse = j = \Delta p = F\Delta t = m\Delta v$$