Physics

Physics First Semester Syllabus

1. How do we describe the motion of an object?

Constant Linear Motion (Chapter 2)

A. Representing motion
B. Time
C. Position, Distance and Displacement
D. Graphs of motion
E. Speed
F. Velocity

Accelerated Linear Motion (Chapter 3)

A. Acceleration
B. Free Fall
C. Graphs of Motion

2. What causes the motion of an object to change?

Forces in One Dimension (Chapter 4)

A. Contact and Non-contact forces
B. Newton's Laws of motion
C. Net force

Forces in Two Dimensions (Chapter 5)

D. Force Vectors
E. Force and motion
F. Gravitation (Chapter 7)

i. Weight
ii. Newton's Law of Universal Gravitation

Energy (Chapters 10 & 11)

A. Work
B. Power
C. Potential Energy
D. Gravitational Potential Energy
E. Kinetic Energy
F. Energy transformations
G. Law of Conservation of Energy

Momentum (Chapter 9)

A. Momentum
B. Impulse
C. Collisions
D. Recoil

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First Semester Final Exam Review & Study Guide

1. Constant and Accelerated Linear Motion (Chapters 2, 3)

A. Position, Distance and Displacement
- What is position?
- What is the difference between distance and displacement?
- A car travels 50m north, then 75m south. What is its total distance traveled? What is its total displacement?

B. Time
- What is time?
- What is the difference between time and a time interval?
- Why is time important in physics?

C. Speed and Velocity
- What is the difference between speed and velocity?
- What is instantaneous speed? What is average speed?
- A car moves 75m north in 3s. What is its speed? What is its velocity?
- A car goes 100m west in 4s, then 75m south in 3s. What is the average speed of the car?
- What does it mean for an object to have constant speed? What does it mean for an object to have constant velocity?
- Can an object travel at constant speed but not constant velocity? How?

D. Acceleration (gravity and sideways)
- What is the definition of acceleration?
- What does a negative acceleration mean?
- What is the difference between acceleration and velocity?

E. Free Fall
- What is the definition of free fall?
- At what rate does the earth accelerate all objects in free fall?
- How far do objects fall in free fall based on time?

F. Graphs of motion (position vs. time and velocity vs. time, slope of line)
- Be able to interpret graphs involving distance, time, speed and acceleration.
- Be able to understand the slope of a line on both types of graphs.

2. Two Dimensional Motion (Chapter 6)

A. Vectors
- What makes a measurement a vector quantity? Give a few examples.

B. Relative Motion
- What does the term "relative motion" mean?
- If you saw a car go by at 20m/s east and a ball is thrown from the car at 15m/s west relative to the car, then what velocity would you the ball have relative to you?

C. Relative Motion
- What is meant by relative motion? How do we measure motion?
- Give 3 examples of objects in circular motion.

3. Forces & Motion (One and Two Dimensional) (Chapters 4, 5, 7)

A. Newton's 1st Law
What is inertia? How does inertia affect the motion of an object?
What is friction? How does friction affect the motion of an object?
What does Newton's first law of motion say?
What is mass? What is the difference between mass and weight?
How much does 1kg on material weigh on Earth? What is the equation for finding weight from mass?
What is the definition of force?
What is net force?
If a box is pushed with a force of 25N north and 35N south, then what is the net force acting on the box?
What is meant when an object is in equilibrium?
Do all objects in equilibrium have to be at rest? Why or why not?
What is the normal force? What is the amount of normal force usually equal to? What is the direction of the normal force?

B. Newton's 2nd Law
What does the term "directly proportional" mean?
If the net force on an object is doubled, then what happens to its acceleration?
What does the term "inversely proportional" mean?
If the mass of an object is doubled, then what happens to its acceleration?
Why does a more massive object have less acceleration? (Because of what property of matter?)
What does Newton's 2nd law say?
What does friction depend on? Is friction limited to solids? Why or why not?

C. Newton's 3rd Law
What does the term "interaction" mean?
How many objects must be involved in any single interaction? What is meant by the system and agent?
What does Newton's 3rd law say?
What is an action force?
What is a reaction force?
Is there a time delay between action and reaction forces?
Be able to identify action and reaction forces
What is true about the amount of force for action and reaction forces?
What is true about the direction for action and reaction forces?
What direction do you push on the ground in order to make yourself move forward?
Do action-reaction forces act on the same object or two different objects?
If an object does not move when you push on it, then how much force acts on it due to friction?
Which has more force acting on it, a gun or the bullet that is shot from the gun? Why?
Which has more acceleration, a gun or the bullet that is shot from the gun? Why?
How does a rocket propel itself in outer space when there is no matter in space for it to push against?
Do Newton's 3rd law pairs of forces (action-reaction) cancel each other out? Why or why not?
When can forces cancel each other out?

D. Two Dimensional forces
How do you find the net force on an object that has many forces in different directions acting on it?

E. Newton's Law of Universal Gravitation (Chapter 7)
How do you use Newton's Law of Universal Gravitation to calculate the force between two massive objects?
How do you calculate the acceleration due to gravity on the surface of a planet?

4. Energy (Chapters 10,11)

A. Energy
What is energy?
What are the different possible forms of energy?
B. Mechanical Energy
What is mechanical energy?
Give a few examples of mechanical energy.
C. Work
What is work? How do you calculate it?
Are work and energy the same thing?
What 3 things must be true for work to be done?
A. Power
What is power? How do you calculate it?
If you do a set of amount of work in twice the time, then what is the power produced?
D. Kinetic Energy
What is KE? How do you calculate it?
If an object is moving three times as fast (with same mass), then how much more energy does it have?
A. Potential Energy
What is PE? How do you calculate it?
If an object is lifted three times as high (with same mass), then how much more energy is stored?
B. Conservation of energy
What does the law of conservation of energy say?
How is the law of conservation of energy used in solving problems?

5. Impulse and Momentum (Chapter 9)

A. Momentum
What is momentum? How do you calculate it?
What is the difference between momentum and inertia?
Can an object have inertia without having momentum?
Can an object have momentum without having inertia?
B. Impulse
What is impulse? How do you calculate it?
What does impulse do to an object?
Can you apply a force without applying an impulse?
Can you apply an impulse without applying a force?
What happens to the amount of force when the time of impact is extended during an impulse?
How does impulse affect the momentum of an object?
C. Conservation of momentum
What does the law of conservation of momentum say?
If a gun shoots a bullet, do they have the same amount of momentum? Why or why not?
If a gun shoots a bullet, do they have the same speed? Why or why not?
How is the law of conservation of momentum like Newton's 3rd law?
D. Collisions & Recoil
What is a collision?
Give an example of a problem that involves a collision.
How does the law of conservation of momentum apply in these types of problems?

What is recoil?
Give an example of a problem that involves recoil.
How does the law of conservation of momentum apply in these types of problems?

6. Other Topics Used All Semester (Chapter 1 and in many others)

A. Metric system
Be able to use meters, grams, Newtons, seconds…and all other metric units and prefixes.

B. Scientific notation
Be able to read and use scientific notation and proper rounding in calculations.

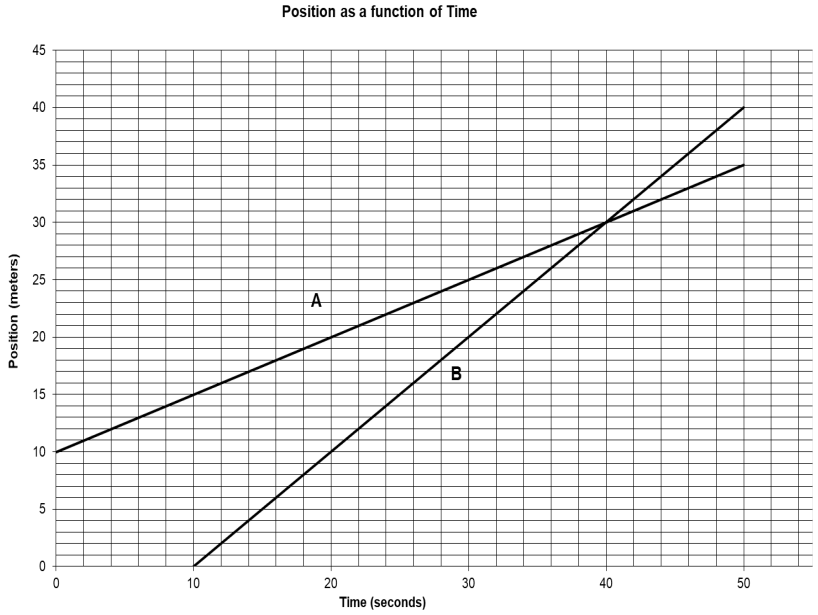
C. Graphs
Be able to read and interpret graphs relating to motion of objects.
Be able to calculate slope from a graph.
Be able to interpret data and trends from a graph.

Physics

First Semester Review Problems

1. How far does a car travel if it averages 30 m/s for 300seconds?
2. A sprinter reaches a speed of 7m/s from rest in 3.7s, what is his acceleration?
3. A car accelerates at 3.8 m/s^2 for 15 seconds, what is its final speed?
4. Can a car travel at a constant speed and accelerate at the same time? How?
5. How long does it take for a ball to hit the ground when dropped from a height of 25m?
6. Bill pushes on an 879kg car with a force of 175N. Ted helps Bill by pushing with 250N. What is the acceleration of the car?
7. Can a car move if it has a net force of zero acting on it? Why/Why not?
8. What is the momentum of a 2,000kg car that is rolling at 25 m/s?
9. A train car (m=1500kg) rolls at 2 m/s into another train car (double the mass), which is at rest. What is the resulting motion of the cars after they couple together?
10. A 50kg kid, riding a 5kg skateboard, rolls at 0.2ms to the right after throwing a 2kg rock to the left at 10m/s. What was the velocity of the kid-skateboard-rock system before the rock was thrown?
11. What is the work done by lifting a 15 kg object 5 meters up?
12. What is the power produced by lifting a 7kg bowling ball 2m high in 1.4 seconds?
13. A 1200kg car exerts 10,500N of force on the ground, what is the maximum acceleration of the car?
14. A treasure map tells you to go 27 paces west of the big rock, then you are to go 9 paces north, 12 paces east, 33 paces south, 25 paces east, 15 paces north and finally west 15 paces. Where did you end up compared to the big rock? (What is your resultant displacement?)
15. A ball is thrown up with a speed of 30 m/s. How high will it go? How long will it take to get to the top?
16. What is the KE of a 7 kg bowling ball that has fallen 5m from rest at the top of a set of stairs? How fast will it be moving at the bottom?
17. How fast will a ball hit the ground if it is thrown straight up at 20 m/s from the ground?
18. Earth travels in an almost circular orbit around the Sun at an average distance of 1.496×10^{11}m. What is the average speed of the Earth as it travels around the Sun in its orbit?
19. Calculate the power produced in lifting a 50kg mass to a height of 10m in 5 minutes.
20. An electron has a mass of 9.11×10^{-31} kg and is found to be moving at 3.00×10^{7} m/s. What is the momentum of the electron? If the electron is stopped by your skin in 0.001s, the how much force did you experience from the electron?
21. Block A has a mass of 1kg and hangs over a frictionless pulley. Block B has a mass of 2kg and hangs on the other side of the pulley. What is the acceleration of the system?
22. Eric watches a car drive by at 15 m/s. Susie drives the car and at the same time throws a tennis ball backwards out of the car window at a speed of 5 m/s relative to the car. At what speed does Eric see the ball moving?
23. Xavier walks at a constant speed of 2 m/s for 150 seconds. How far did he travel?
24. Smedley drives from Howell to Ann Arbor at an average speed of 30 m/s. If Howell is 55,000 m from Ann Arbor, then how long did his trip take?

25. Can an object travel at constant speed but not constant velocity? Explain why or why not?
26. A car travels at 20m/s and covers 2,000m, the car then travels 2,000m at 30m/s. What is the average speed of the car for the whole trip?
27. A ball falls from rest atop a 25 meter tall building. How long did the ball take to hit the ground? How fast was it going just before it hit the ground?
28. How would air resistance affect the acceleration of a falling object?
29. What is the weight of a 1200kg car on Earth's surface? On Jupiter? What is the weight of a 1kg mass when is $6x\ 10^6$m above the surface of Earth?
30. What is the acceleration of a 1200kg car that exerts a force of 10,500N on the ground?
31. A boat pulls a water skier and the skier pulls back equally hard on the boat. Why don't the forces cancel out?
32. What is the momentum of a 1200kg car moving at 25m/s?
33. What is the amount of impulse required to stop a 1200kg car that is moving at 25m/s?
34. Why are seatbelts and airbags important safety devices in cars?
35. A 1,000kg train car at 2 m/s connects with a 2,000 kg train car that is moving at 3m/s in the opposite direction. What is the final speed of the connected cars?
36. A ball is thrown straight up with a speed of 18m/s. How long until it reaches its highest point? How high will it go?
37. What is the PE of a 1.5kg box on top of a 2.8m high shelf? If it falls, then what is its KE just before hitting the ground? What is its speed just before hitting the ground? What is its speed ½ of the way down?
38. If a spaceship travels at 2×10^6 m/s for 4×10^{12} seconds, then how far does it travel?



39. Calculate the slope of each line. What information does this give?
40. Predict the position of car B at 70 seconds.
41. What is the displacement of car A between t=5 s and t=25 s?
42. What is happening at 40 seconds?
43. Do both cars start at the same position? Why or why not?

General Hints and Ideas for Study:

Bring a working calculator to the exam, a couple of #2 pencils and a single page (8 ½" x 11") of hand written notes to help you on the exam.

I will not have any spare calculators to lend out during the exam, so please come prepared.

Review each unit study guide, old quizzes and problems given in class as needed.

Practice using the equation sheet on the review problems, just as you would have to on the exam.

The exam will cover almost every physics content expectation listed in this review packet.

Example of equation page given on the exam.

Equations:

$v = \Delta x / \Delta t$
$\Delta x = v \Delta t$
$\Delta t = \Delta x / v$

$a = \Delta v / \Delta t$
$\Delta v = a \Delta t$
$\Delta t = \Delta v / a$

$v_f = v_i + a \Delta t$
$v_i = v_f - a \Delta t$
$a = (v_f - v_i) / \Delta t$
$\Delta t = (v_f - v_i) / a$

$\Delta x = v_i t + ½ a \Delta t^2$
$\Delta x = ½ a \Delta t^2$
$\Delta t = \sqrt{(2 \Delta x / a)}$
$a = 2 \Delta x / \Delta t^2$

$v = (v_i + v_f) / 2$

$a = F / m$
$F = m a$
$m = F / a$

$F_g = G m_1 m_2 / r^2$
$a_g = G m / r^2$

$p = m v$
$v = p / m$
$m = p / v$

$J = F \Delta t$
$F = J / \Delta t$
$\Delta t = J / F$

$\Delta p = \Delta(m v)$
$\Delta v = \Delta p / m$
$m = \Delta p / \Delta v$

$F t = \Delta(m v)$
$F = \Delta(m v) / t$
$t = \Delta(m v) / F$
$\Delta v = F t / m$
$m = F t / \Delta v$

$(m_1 v_1)_i + (m_2 v_2)_i = (m_1 v_1)_f + (m_2 v_2)_f$
$(m_1 v_1)_i + (m_2 v_2)_i = (m_1 + m_{2)} v_f$
$(m_1 + m_{2)} v_i = (m_1 v_1)_f + (m_2 v_2)_f$

$W = F \Delta x$
$F = W / \Delta x$
$\Delta x = W / F$

$P = W / \Delta t$
$W = P \Delta t$
$\Delta t = W / P$

$PE_g = m g h$
$h = PE_g / m g$
$m = PE_g / g h$

$KE = ½ m v^2$
$v = \sqrt{(2 KE / m)}$
$m = 2 KE / v^2$

circumference = $2 \pi r$

Constants, Information and Other Data:

Earth's acceleration due to gravity = 9.8 m/s^2 or 10 m/s^2 (rounded)

Universal gravitational constant $G = 6.67 \times 10^{-11}$