Name______________________________ Date________

Physics I

MID-YEAR EXAM STUDY GUIDE

Core Ideas:

Models in Physics –

Conceptual models are made through simplification ("the earth is a sphere") or analogy ("the earth is like an egg").

Mathematical models are made by writing equations describing the pattern shown in a graph of two variables.

Every term in a mathematical model must have the same overall units ("apples + apples = apples")

Units & Conversion -

Standard units in physics – meters for length, seconds for time, kilograms for mass

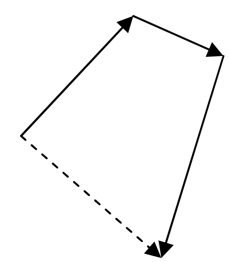
Unit Conversion – multiply a number by versions of one (fractions where the top = the bottom) so that the final answer is the same amount, but expressed in different units

Fermi questions estimate the answers to difficult questions by being inventive in creating reasonable "versions of one"

Vectors -

Vector quantities have both magnitude (size) and direction.

Direction in one dimension can be indicated by + and -. Direction in two dimensions needs to be specified with an angle.



Vectors to be added must be drawn "Head-to-Tail". The resultant (dashed line) of adding vectors goes from the starting point of the first vector to the ending point of the last vector.

The equilibriant is a vector equal in magnitude but opposite in direction to the resultant.

Calculating components from magnitude and direction: Components of a vector specify how much of the vector is in the x-direction and how much is in the y-direction. $Rx = R\cos\Theta$, $Ry = R\sin\Theta$

Calculating magnitude and direction from components: The magnitude of the resultant is given by the Pythagorean theorem - $|R| = \sqrt{\Sigma R_x^2 + \Sigma R_y^2}$ The direction is given by trigonometry – $\mathrm{Tan}^{-1}(\Sigma R_y/\Sigma R_x) = \Theta$

1D Motion –

There are a lot of different terms to keep track of in motion problems:

$v_i, v_f, \bar{v}, \Delta v, a, \Delta t, \Delta s$.

We organize them in a really good motion chart. Each row corresponds to a particular motion – each row MUST correspond to a motion where the acceleration is constant the whole time, which is an assumption built into all our motion equations.

v_i	v_f	$\bar{v}$	Δv	a	Δt	Δs

Vertical motion "through the air" is always affected by the acceleration due to gravity, whose value changes depending on what planet you are on.

FRICTIONLESS motion on a ramp depends only on the acceleration due to gravity and the angle of the ramp ($a_{//} = g \sin\Theta$). This does NOT apply if objects are rolling or if friction is present.

The slopes and areas of graphs are meaningful. Since slope = $\Delta y/\Delta x$, slope of position vs. time = $\Delta s/\Delta t$ = velocity, slope of velocity vs. time = $\Delta v/\Delta t$ = acceleration

Since area = y * x, the area under a velocity vs. time graph = v * t = Δs; the area under an acceleration vs. time graph = a * t = Δv.

Newton's Laws –

(1st) Object in equilibrium ↔ Object not accelerating ↔ $\Sigma F = 0$ ↔ $\Sigma F_L = \Sigma F_R$, $\Sigma F_U = \Sigma F_D$

(2nd) Object NOT in equilibrium ↔ Object accelerating ↔ $\Sigma F = ma$ ↔ W-L = ma

(for circular acceleration, $\Sigma F = F_c = ma_c$)

(3rd) Object A pushes on Object B ↔ Object B pushes on Object A ↔ $F_{A\ on\ B} = -F_{B\ on\ A}$

Free Body Diagrams – DON'T ASSUME!

F_g or W = attraction between two masses; always straight down on surface of earth

$F_\perp$ = normal force; requires a solid supporting surface touching object; always ⊥ to surface; NOT always vertical

F_f = friction force; direction is determined by which way the object would slide if friction were not present; always pushes to oppose sliding

$F_{//}$ = NOT its own force; only present on ramps; shorthand for the SUM of F_g and $F_\perp$; points down the ramp

F_T or T = tension; always a pull, and always in the direction of the string/rope/chain

$F_{applied}$ or F_{pull} or F_{push} = any other external force described in the problem; directed as described in the problem

With the exception of gravitational forces, all other forces we have considered so far require contact between two objects!

All Vectors -

Can only be reliably added by DRAWING A PICTURE in which the vectors are positioned head-to-tail. The correct math to use is obvious from the picture.

Units Menagerie – units and their associated quantities

m/s = speed or velocity
m/s^2 = acceleration
N = force (including weight) =$kg*m/s^2$
kg = mass

Universal Gravitation –

All bits of mass in the universe attract all other bits of mass in the universe. The strength of this attraction depends on the amounts of mass in each object, the distance between the objects, and the gravitational constant (big) G.

Practice:

1) A sports car goes from 10 m/s to 35 m/s in 8 seconds. Fully analyze its motion.

v_i	v_f	$\bar{v}$	Δv	a	Δt	Δs

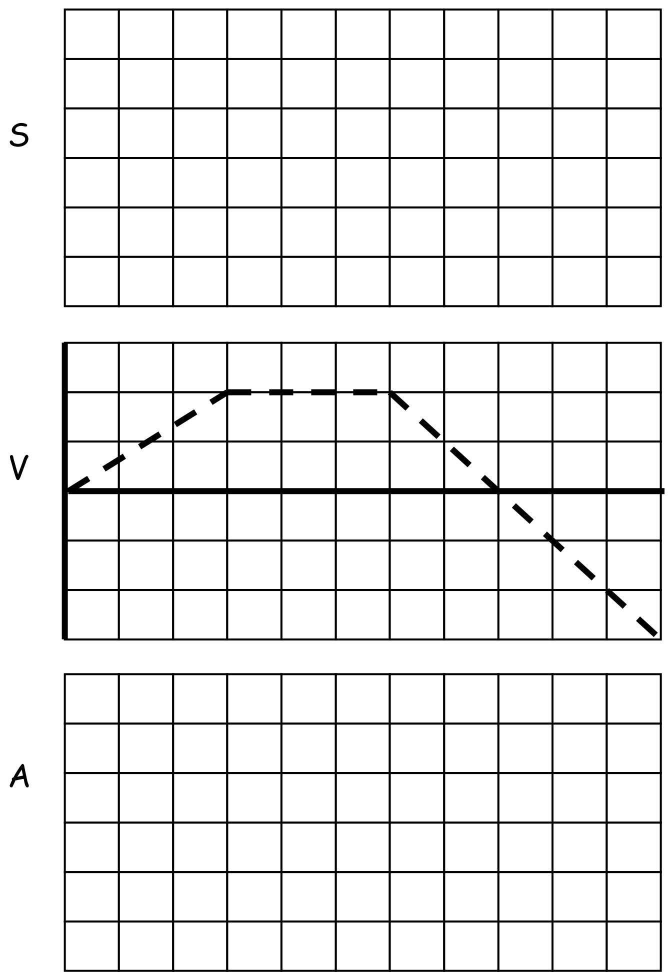
2) Wile E. Coyote (44 kg) is tricked into stepping off an 80 m high cliff. Find his speed after he has fallen 40 m and just before he hits the ground.

v_i	v_f	$\bar{v}$	Δv	a	Δt	Δs

3) A puck slides down a 3 meter long ice ramp in 2 seconds. Fully analyze this motion. What is the angle of the ice ramp?

v_i	v_f	$\bar{v}$	Δv	a	Δt	Δs

4) Construct **s** and **a** motion graphs from the **v** graph provided. $\mathbf{s_i} = 0$.



- On all the graphs, each horizontal box = 1 sec.
- On the **v** graph, vertical boxes are 2 m/s each.

Create **<u>appropriate</u>** scales for the **s** and **a** graphs. Show work here!

Describe the motion of the object represented in the above stacked graphs. Be as detailed as possible.

5) A 700 kg car is driving down the highway at 20 m/s. What is the total force acting on it?

6) A 7 kg wagon is being pulled at 1 m/s^2. What is the total force acting on it?

7) A 25 kg box is being pushed by two people on a frictionless floor. It is being pushed with 60 N to the east and 110 N to the west. What is the total force on the box? What is its acceleration? Fully analyze its motion over 10 meters.

v_i	v_f	$\bar{v}$	Δv	a	Δt	Δs

8) A 400 kg boulder is being pushed by two front-end loaders. It is being pushed with 2300 N to the north and 1700 N to the east. What is the total force on the boulder? What is the boulder's acceleration? Fully analyze its motion over 4.5 seconds.

v_i	v_f	$\bar{v}$	Δv	a	Δt	Δs

9) Name the "third law" pair for each force:
Loader pushes south on boulder with 350 N.

Sun pulls up on person with 0.4 N.

10) Draw free-body diagrams for each of the following situations. To the side, show the addition of the forces (using solid arrows) and the total force (using a dashed arrow).

(biker going around track)

(FBD for soccer ball)

(Skier moving straight at constant velocity)

(Draw FBD's for each car; Car on left pulling
car on right; track is horizontal; cars are speeding up)

(man is accelerating downward)

11) A 650 kg elevator has a maximum upward acceleration of 4 m/s^2 and a maximum cruising speed of 12 m/s. The elevator has an 85 kg passenger standing on a scale. What does the scale read when the elevator is accelerating upward at its maximum rate? What does the scale read when the elevator is moving upward at its maximum cruising speed? How much time will it take the elevator to reach maximum speed? How much time will it take the elevator to travel 100 meters, starting from rest?

12) A clown (68 kg) takes a break and goes for a ride on the Devil's Hole ride. The ride has a radius of 3 m and rotates twice every second. Draw a FBD, find the magnitude of all the forces on the clown, and find the minimum coefficient of friction to keep him from sliding into the depths.

13) A 31 kg box is pulled horizontally along a floor. The coefficient of friction between the box and the floor is 0.4 and the box is accelerating at 4.6 m/s^2. What is the force pulling the block across the floor?

14) A dirt bike racer rides her bike (combined mass = 105 kg) around a 25 m radius track twelve times in five minutes. What is the average speed, centriptal acceleration, and centripetal force on the biker? What is the minimum coefficient of friction needed to keep the biker going around?

15) A 94 kg sign hangs from two chains, one at 70° to the horizontal and the other at 30° to the horizontal. Find the tension in the two chains.

16) An Atwood machine consists of a 12 kg mass that starts on the floor and a 16 kg mass that starts off just below the pulley, 2 m off the floor. Analyze the Atwood machine using forces to find the acceleration of the blocks and the tension in the rope. How long will it take the upper block to hit the floor?

17) An object that weighs 425 N on the earth's moon weighs 350 N on Ganymede (one of Jupiter's moons). What is the acceleration due to gravity on Ganymede?

18) Find the average speed for the earth traveling around the sun. Also, find the gravitational force between the earth and the sun.