Physics I **Name** ____________________________

Semester 1 Study Guide **Date** ___________ **Period** __________

1. Be able to determine the change in position of an object based on a description of its motion.
2. Recognize that "change in position" is also called "displacement."
3. Be able to determine the distance that an object has moved along one dimension and to distinguish the distance moved from the displacement.
4. Be able to determine the average velocity of an object.
5. Be able to determine the average speed of an object.
6. Given a position vs time plot for an object, be able to figure out
   (a) the displacement of the object over a specified interval of time,
   (b) the distance it traveled during the time interval,
   (c) its average velocity over a specified interval of time.
   (d) its average speed over a specified interval of time,
   (e) its instantaneous speed at any specified moment
   (f) and also its direction of motion, whether positive or negative.
7. Be able to distinguish among average velocity, instantaneous velocity, initial velocity, and final velocity.
8. Be able to distinguish between average speed and average velocity.
9. Be able to define average acceleration in your own words, mathematically, and graphically.
10. Be able to describe to someone else the differences between velocity and acceleration in words, graphs, equations, and motion diagrams.
11. Be able to use the velocity *vs* time plot for an object moving in one dimension
    (a) to determine the object's average acceleration over a specified interval of time,
    (b) to find the displacement of the object over some specified interval of time,
    (c) and to describe the motion of the object in words including its direction of motion.
12. Be able to use an a *vs* t plot to determine
    (a) the acceleration of an object, and
    (b) the change in velocity of an object over some specified amount of time.
13. Be able to match x *vs* t, v *vs* t, and a *vs* t plots that describe objects having the same motion.
14. Be able to use the following kinematic relationships to solve problems and to list the conditions under which they are valid.
    - $\overline{\mathbf{v}} = \dfrac{\Delta \mathbf{x}}{\Delta t}$
    - $\overline{\mathbf{a}} = \dfrac{\Delta \mathbf{v}}{\Delta t}$

- $\Delta x = v_0 \Delta t + \frac{1}{2} a \Delta t^2$
- $v_f^2 = 2a\Delta x + v_0^2$

15. A bullet moving horizontally to the right (+x direction) with a speed of 500 m/s strikes a sandbag and penetrates a distance of 10.0 cm. What is the average acceleration of the bullet?

    (a) -1.25×10^3 m/s^2
    (b) -1.25×10^6 m/s^2
    (c) -2.50×10^3 m/s^2
    (d) -2.50×10^6 m/s^2

16. A jet fighter plane is launched from a catapult on an aircraft carrier. It reaches a speed of 42 m/s at the end of the catapult, and this requires 2.0 s. Assuming the acceleration is constant, what is the length of the catapult?

    (a) 24 m
    (b) 42 m
    (c) 16 m
    (d) 84 m

17. A car starting from rest moves with constant acceleration of 2.0 m/s^2 for 10 s, then travels with constant speed for another 10 s, and then finally slows to a stop with constant acceleration of -2.0 m/s^2. How far does it travel?

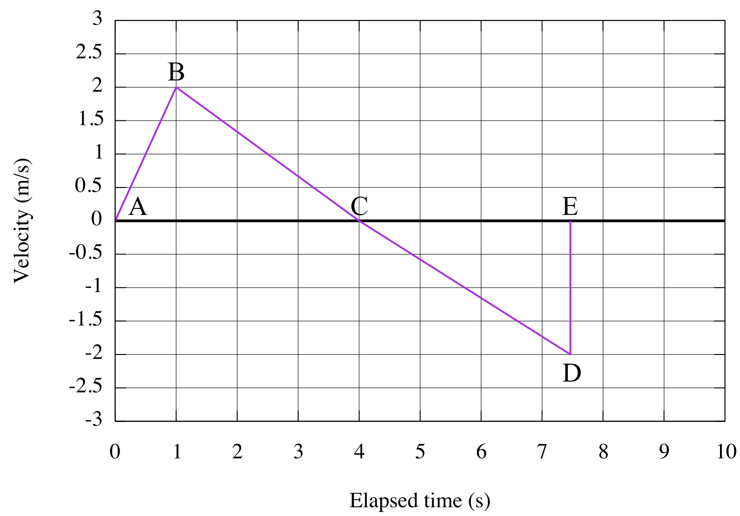
    (a) 200 m
    (b) 500 m
    (c) 400 m
    (d) 300 m

    26) A car goes from 40 m/s to 80 m/s in a distance of 200 m. What is its average acceleration?

    (a) 8.0 m/s^2
    (b) 24 m/s^2
    (c) 12 m/s^2
    (d) 9.6 m/s^2

For the next five items

A ball is pushed up from the lower end of a ramp by a student. Then the ball continues to roll up the ramp, slowing as it goes, until it turns around and rolls back down to where it started. The following graph shows the velocity of the ball as a function of time.



18. The area of the triangle ABC is exactly equal to the area of triangle CDE because:

    (a) the ball rolls up the ramp and back down with the same acceleration each way.
    (b) the speed with which the ball rolls down on its return is equal to its greatest speed.
    (c) the ball is at rest at the top of its flight.
    (d) the distance that the ball rolls up the ramp is equal to the distance it rolls back down the ramp.
    (e) particular values of time and velocity were chosen for this problem to ensure this equality.

19. The acceleration of the ball while it was being pushed by the student is approximately

    (a) 1.0 m/s^2
    (b) 2.0 m/s^2
    (c) -0.67 m/s^2
    (d) -9.8 m/s^2
    (e) None of the above

20. The distance through which the student is pushing the ball is approximately

    (a) 2 m
    (b) 5 m
    (c) 1 m
    (d) 0.5 m
    (e) 1.5 m

21. The ball reaches it maximum height at time:
    (a) 0.5 s
    (b) 1.0 s
    (c) 4.0 s
    (d) 7.4 s
    (e) None of the above.

22. The maximum distance up the ramp that the ball rolls is approximately:
    (a) 1 m
    (b) 2 m
    (c) 4 m
    (d) 5 m
    (e) 8 m

Chapter 4 Review

1. Sketch a graph that shows how the force of kinetic friction on an object depends on the supporting force exerted on that object by the surface it moves on.

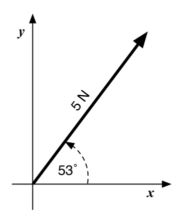
2. What advantage does antilock braking provide with respect to friction?

3. What are the fundamental units (*i.e.* in terms of kg, m, and s) for the Newton, our unit of force?

4. How strong is the Moon's gravitational field at its surface? Be sure to include its units!

5. Suppose you have a mass of 50 kg. What will be the magnitude of the gravitational force on you if you were on the Moon?

6. Find the x and y components of the vector shown with respect to these coordinate axes.



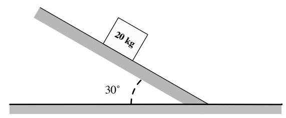
7. State Newton's 1^{st} Law and describe real phenomena that illustrate it.

8. **T** or **F** The surface force supporting an object is always equal to the gravitational force acting on that object.

9. Two bodies are allowed to fall freely from the same location, one of which is released a short time before the other. If the air resistance can be neglected while they are falling,
    (a) the two bodies have the same acceleration.
    (b) their speeds always differ by the same amount.
    (c) their distance of separation is always the same.

i. a), b), and c)
ii. a) and b) only
iii. b) and c) only
iv. a) only
v. c) only

10. A box sits on a ramp as shown. It remains stationary. The coefficients of friction for the box and ramp are $\mu_s = 0.8$ and $\mu_k = 0.6$.



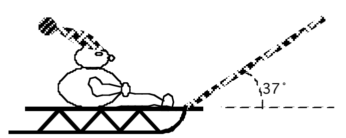
(a) Sketch and label a force diagram for this ramp.
(b) Find the magnitude of each force acting on the box.

11. An asteroid moving North at 60 km/s slams into a paper mache astronaut clown, making the clown fly apart. How does the force the asteroid exerts on the clown compare to the force the clown exerts on the asteroid?

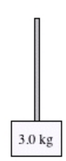
12. A 70 kg paratrooper carrying 30 kg of equipment is descending by parachute at a steady 10 m/s.

(a) Sketch and label a force diagram for this paratrooper with his equipment.
(b) Find the magnitude of each force acting on the paratrooper and his equipment.

13. Out of the kindness of your heart you have volunteered to tug Junior around on a sled. Junior and the sled together comprize a mass of 40. kg. The coefficient of kinetic friction between the sled runners and the snow is $\mu_k = 0.10$. You pull on the sled rope with a force of 100. N at an angle of 37° above horizontal.



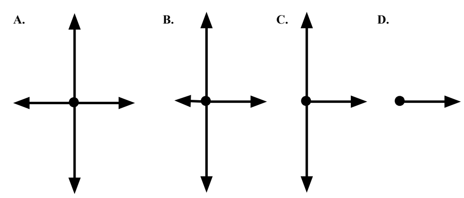
(a) Sketch and label a force diagram for the sled/boy system.
(b) Find the magnitude of each force acting on the sled/boy system.



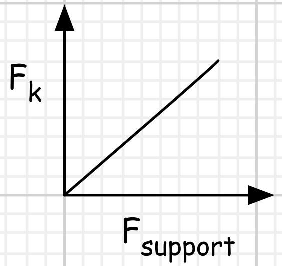
14. A rope of negligible mass supports a block that has a mass of 3.0 kg, as shown above. The breaking strength of the rope is 50 N. The largest acceleration that can be given to the block by pulling up on it with the rope without breaking the rope is most nearly

(a) 6 m/s^2
(b) 6.7 m/s^2
(c) 10 m/s^2
(d) 15 m/s^2
(e) 16.7 m/s^2

15. You horizontally push a crate of furniture at a constant velocity to the right across a carpet. Which of the following force diagrams best represents the crate?



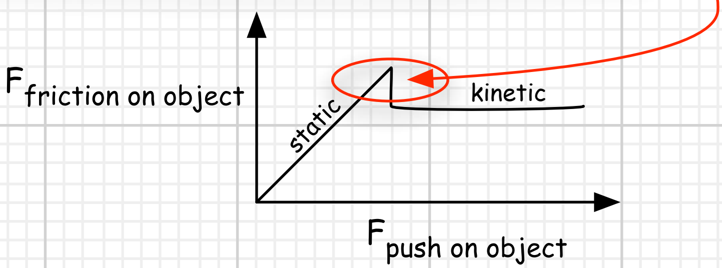
1.



$F_k \propto F_{support}$

$F_k = \mu_k F_{support}$

2. Antilock brakes prevent wheels from locking. The tires continue to roll, assuring that there is no relative motion between the road and the region of the tire that is in contact with the road. When wheels lock, the tires skid across the pavement, and the friction force is described by $F_k = \mu_k F_{support}$. If the tires do not skid, then we are dealing with static friction between tire and road, which is described by $F_s \leq \mu_s F_{support}$. Because $\mu_s > \mu_k$, the static friction force between road and tire can possibly be bigger than the kinetic friction. Antilock brakes are engineered to let the static friction force rise up into that range where it is bigger than the kinetic friction force.



3. The unit of force, the Newton, is defined in accordance with $\mathbf{F}_{net} = m\mathbf{a}$.

Therefore, N = kg(m/s^2)

4. The point of this is to make you think about what "g" actually represents. It does not always mean 9.8 N/kg, because gravitational fields con be stronger or weaker. The strength of the gravitational field at the surface of the Moon is 1.6 N/kg.

5. The gravitational force on a 50 kg object on the Moon is given by the gravitational force law, $\mathbf{F}_{grav} = m\mathbf{g}$. So the magnitude of the force of gravity on a 50 kg object on the Moon will be 80 N.

6. The x component is obtained from $\mathbf{F}_x$= (5 N)cos(53°) = 3 N, approximately.

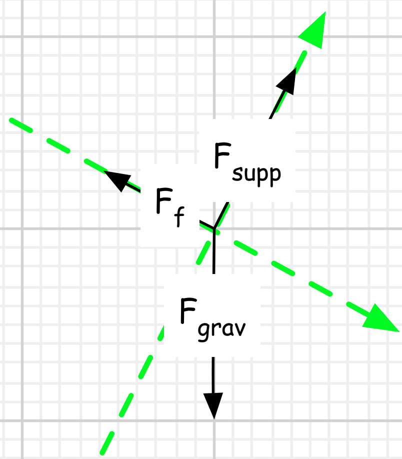
The y component is obtained from $\mathbf{F}_y$= (5 N)sin(53°) = 4 N, approximately.

7. An object that is subject to zero net force will have a constant **velocity**. Any object moving with a constant speed in a straight line would be an example.

8. False. Examples would be the force supporting an object on a ramp, the force supporting a sled being pulled with a rope that is angled upward, and the force supporting a broom that you push. In the first two examples, the support force is less than the gravitational force. In the third example, the support force is greater than the gravitational force, because of the downward component of the force exerted on the broom by the person pushing it.

9. This is a tough one to answer, because people try to use intuition without using Newton's Laws of Motion to help their intuition. The correct answer, which is only rarely chosen, is ii) a and b only. Choice "a" works, because, as we showed in Ch 4 Assign 1, all object must fall with the same acceleration using $\mathbf{F}_{grav} = \mathbf{mg}$ **and** $\mathbf{F}_{net} = \mathbf{ma}$. Choice B works, too: If you do a quick mental calculation, using g = 10 N/kg, then if you drop Object B 2 seconds after dropping Object A, then it is not too hard to see that Object A would be falling at that moment with a speed of 20 m/s and Object B would be at 0 m/s, just having been dropped. A second later the speeds would be 30 m/s and 10 m/s. So you can see that in both cases Object A is traveling 20 m/s faster than Object B. But Choice c fails. Two objects that always are the same distance apart must have the same speed. Think about it, for example, in terms of cars on a highway. By the way, the most common answer, which is wrong, is iii). The lesson here is, when in doubt, force yourself to try to use Newton's Laws of Motion.

10.



x forces: $\mathbf{F}_{grav,x} - \mathbf{F}_f = ma_x$

y forces: $\mathbf{F}_{supp} - \mathbf{F}_{grav,y} = ma_y = 0$ by design

$\mathbf{F}_{grav,x} = 200 \sin(30°)$
$\mathbf{F}_{grav,y} = 200 \cos(30°)$

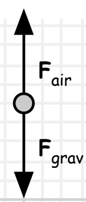
$\mathbf{F}_{grav} = \mathbf{mg} = \mathbf{200\ N}$

$\mathbf{F}_{supp} = 173$ N from knowing the y forces must add up to zero.

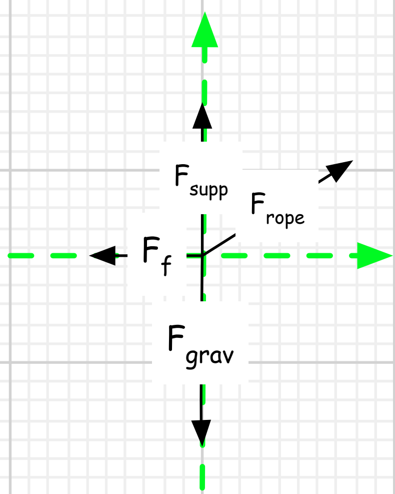
either it's stopped:
$\mathbf{F}_f \leq 0.8(173\ \text{N})$
or it's sliding:
$\mathbf{F}_f = 0.6(173\ \text{N})$
Since $\mathbf{F}_{grav,x} = 100$ N, static friction is more than enough to keep it at rest. So $\mathbf{F}_{net} = 0$, and $\mathbf{F}_f$ must be 100 N, so that there is no net force along the x axis.

11. The force that the asteroid exerts on the paper mache clown is the same as the clown exerts on the asteroid, only in the exact opposite direction. Whenever Object A exerts a force on Object B, Object B exerts an equal and opposite force on Object A.

12. A constant downward speed means a constant velocity. A constant velocity means zero acceleration. $\mathbf{F}_{net}$ = ma = 0. Therefore, the upward force exerted by the air on the parachute/paratrooper will be equal to the downward force exerted by Earth's gravitational field on the parachute/paratrooper. $\mathbf{F}_{grav}$= mg = 1000 N. Therefore, F_{air}= 1000 N.



13.



x forces: $\mathbf{F}_{rope,x} - \mathbf{F}_f = ma_x$

y forces: $\mathbf{F}_{supp} + \mathbf{F}_{rope,y} - \mathbf{F}_{grav} = ma_y = 0$ by design

$\mathbf{F}_{rope,x}$= 100 cos(37°) = 80 N
$\mathbf{F}_{rope,y}$= 100 sin(37°) = 60 N

$\mathbf{F}_{grav}$= mg = **400 N**

$\mathbf{F}_{supp}$= 340 N from knowing the y forces must add up to zero.

It is sliding.
$\mathbf{F}_f$ = 0.1(340 N) = 34 N

14. The maximum upward acceleration arises from the maximum upward net force. That will occur when you pull up the maximum amount possible: 50 N. Thus Newton's 2nd looks like: 50 N - 30 N = (3 kg)a. Solving for "a" gives us 6.7 m/s^2.

15. The answer is A. Constant v means zero net force.