2016-2017
Level I Physics
Midterm Exam

KEY

Name: **key Level I Physics pd:3**

Exam Date: **Thursday, January 12, 2017**

Exam Time: **7:55**

Exam Room: **234**

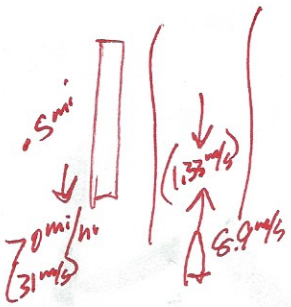
Directions: Solve all problems on the exam. Show all work. Circle your answer. Each is worth 5 points. You will need the following to take this test:

-pencils, black pen, blue pen.

-equation card

-Calculator

1) A half-mile long train is traveling along a river valley, heading downhill at 70 miles per hour (31m/s). The fast moving water is traveling at 3 miles per hour (1.33m/s). While in your boat, you are heading upstream at 20 miles per hour (8.9 m/s) WRT water when you pass the engine of the 0.5-mile long train. How long does it take for you to pass the back end of the train?



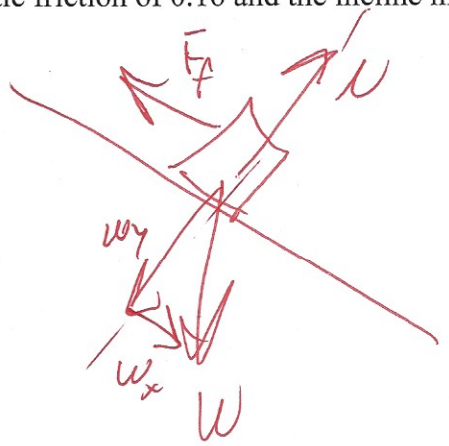
20s

31 m/s ↓ ↑ 7.57 m/s

↑ 38.57 m/s for 600m

.0056 hr

2) A box is on an incline. Determine the acceleration of the box if there is a coefficient of kinetic friction of 0.16 and the incline makes an angle of 39 degrees above the horizontal.



$\Sigma F_y = N - w_y = 0$

$N = mg\cos\theta$

$\Sigma F_x = w_x - F_f = ma$

~~$mg\sin\theta = ma$~~

$mg\sin\theta - \mu N = ma$

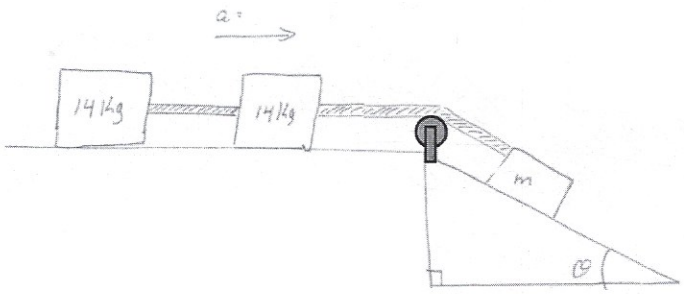
$mg\sin\theta - \mu mg\cos\theta = ma$

$g\sin\theta - \mu g\cos\theta = a$

$g(\sin\theta - \mu\cos\theta) = a$

$4.4\frac{m}{s^2} = a$

3) All boxes are frictionless. Determine the mass of the box on the incline for the boxes to accelerate at 3 m/s^2. The angle indicated is 23 degrees



$\Sigma F_x = m_A g \sin\theta = m_{ABC} a$

$m_A g \sin\theta = (m_A + m_B + m_C) a$

$m_A g \sin\theta = m_A a + m_B a + m_C a$

$m_A g \sin\theta - m_A a = (m_B + m_C) a$

$m_A = \dfrac{(m_B + m_C) a}{(g \sin\theta - a)}$

$m_A = \dfrac{(28\,kg)(3\,m/s^2)}{[(9.8\,m/s^2)(\sin 23^\circ) - 3\,m/s^2]}$

$m_A = 101\,kg$

4) A roller coaster has a lift hill that is 12m above the ground. The track tops this lift hill going almost straight down to just above the ground, then back up a second hill that is 11 m above the ground. Determine how fast the train is traveling at the top of this second hill. Assume there are no losses of energy.

$PE = KE$

$gh = \frac{1}{2}v^2$

$\sqrt{2gh} = v = \sqrt{(2)(9.8\,m/s^2)(1\,m)} = v$

$v = 4.4\,m/s$

5) A motor is rated 25h.p. (18,650 W). Determine how long it will take to lift 15,000kg roller coaster train to the top of 22m high hill.

$P = \frac{W}{t}$

$t = \frac{Fx}{P} = \frac{(15{,}000\,kg)(9.8\,m/s^2)(22\,m)}{18{,}650\,W}$

$t = 173\,s$

2.64 min

6) A 8-pound object stretches a spring 4 inches. How heavy is something that stretches the spring 6.5 inches? (Feel free to work in pounds and inches)

$k = k$

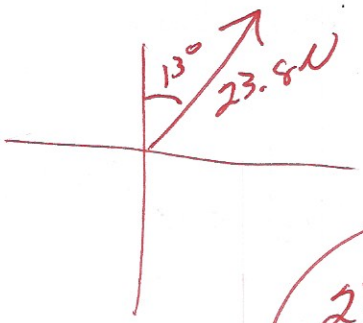
$\frac{F_1}{x_1} = \frac{F_2}{x_2}$

$\frac{8\,lb}{4\,in} = \frac{x}{6.5\,in}$

$x = 13\,lb$

57.2 N

7) Resolve the following vector: 23.8 N @ 13 degrees east of north.



23.1 North
5.35 East

8) Consider the lift hill on a roller coaster. There is a chain that runs on a sprocket containing 134 teeth. The lift hill is 30 m long and 16 m tall. The mass of train is 3200kg. The train consists of 12 rows of 2 seats and takes 60 seconds to top the hill, and an additional 75 seconds to run the rest of the run. Determine the "ideal" amount of work to get the train to the top of the hill.

$(16m)(3200kg)(9.8 m/s^2)$

501760 J

9) You are able to walk at 3 mph. (This is a typical walking speed, although it may be a little fast for some). How long should it take you to walk to the Sheetz on the corner of Winding Hill and Market? That store is 2.3 miles away according to Google.

.76 hr = 46 min

10) A municipality restricts their police patrol cars from exceeding 80 mph (35.8 m/s) during a car chase (they may go faster to respond to a call). A speeding car passes a patrol car doing 65 mph (29 m/s). The officer takes 8 seconds to radio in the infraction, then gives chase accelerating at 2.8 m/s^2. The speeding car maintains a constant speed the entire time. What distance does the patrol car travel to catch the car?

232m

WRT speeder

$v_0 = -29\ m/s$

$x = ?$ (Distance from car)

$v = 64.8\ m/s$

$a = 2.8\ m/s^2$

$v^2 = v_0^2 + 2ax$

$\frac{(64.8\ m/s)^2 - (29\ m/s)^2}{2(2.8\ m/s^2)} = x = 594m$ ... past speeder?

t For x=0

$t = ?$

$v_0 = -29\ m/s$

x-zero

$a = 2.8\ m/s$

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

$-v_0 t = \frac{1}{2} a t^2$

$-v_0 = \frac{1}{2} a t$

$29\ m/s = \left(\frac{1}{2}\right)(2.8\ m/s^2)\, t$

$20.7\ s = t$

$232m = (-29\ m/s)t + \frac{1}{2}(2.8\ m/s^2)t^2$

$1.4t^2 - 29t - 232 = 0$

Time To 80mph

$\frac{v}{a} = t = \frac{35.8\ m/s}{2.8} = 12.8s$

$v = v_0 + at$

2196m

11) A car merging onto the highway is initially traveling at 30 mph (13.4 m/s). If the car accelerates at 2.0 m/s^2, what distance will the car travel while it accelerates to 60 mph (26.8 m/s)?

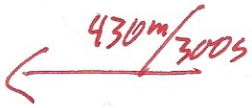
$(\cancel{13.4\ m/s})^2 =$

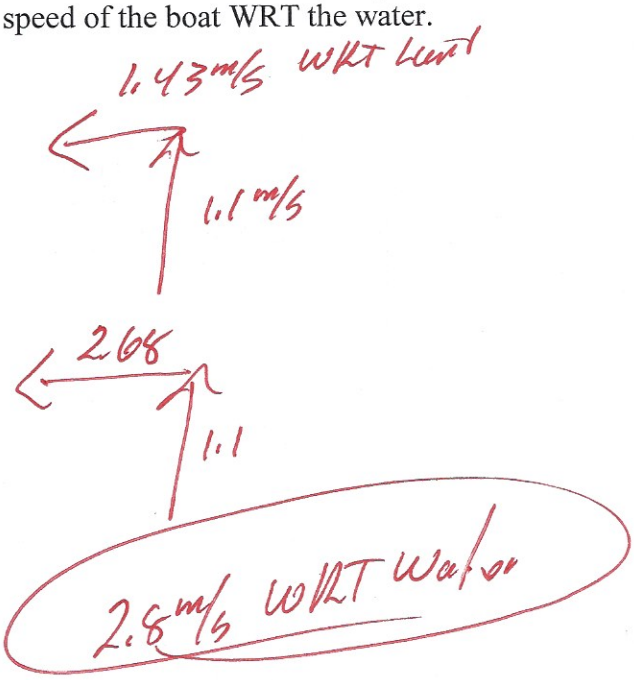
$(26.8\ m/s)^2 = (13.4\ m/s)^2 + (2(2\ m/s^2)) x$

718.24

$\frac{536}{4} = 134.7\ m$

12) A river is flowing at 1.25 m/s WRT land. You are with your boat on the near shore hoping to cross the river to the far shore in a time of 5 minutes. The river is 330m wide, and you plan to land on the far side 430 m upstream. Determine the required speed of the boat WRT the water.

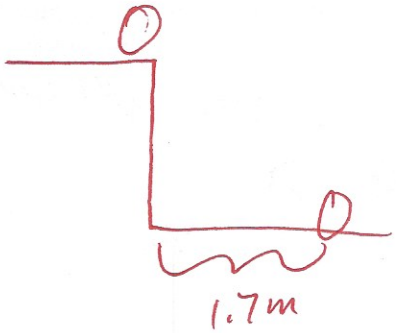




13) A cannon is positioned at the bottom of a cliff that is 32 m high. The cannon is aimed at 76 degrees above the horizontal. The cannon will launch the projectile at 80 m/s. Determine the speed of the projectile at the highest point of the trajectory.

19.4 m/s

14) A ball rolls off a table that is 67 cm above the floor. If the ball lands 1.7m out from the edge of the table, determine how fast the ball was rolling on the table.



$x = \frac{1}{2}at^2$

$\sqrt{\frac{2x}{a}} = t = \sqrt{\frac{(2)(.67)}{9.8}} = t = .37s$

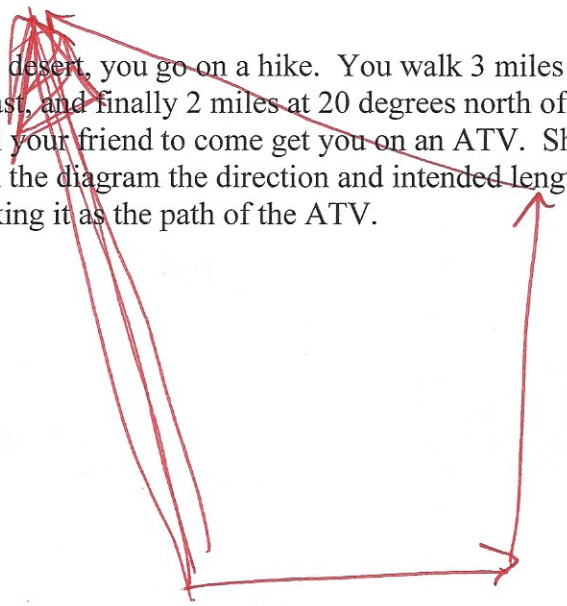
4.6 m/s

15) A cannon fires a projectile at 84 m/s. Determine the angle needed to hit a target that is 12 m away.

$$x = \frac{v_0^2 \sin 2\theta}{g}$$

$$\frac{\sin^{-1}\left(\frac{xg}{v_0^2}\right)}{2} = \theta = 0.5^\circ \text{ or } 89.5^\circ$$

16) While camping in the desert, you go on a hike. You walk 3 miles due east, then 5 miles due north, then 6 miles due east, and finally 2 miles at 20 degrees north of west. At this point, you are exhausted, so you call your friend to come get you on an ATV. Show the vector addition as a sketch being very clear in the diagram the direction and intended length of each segment. Show the path of the ATV marking it as the path of the ATV.



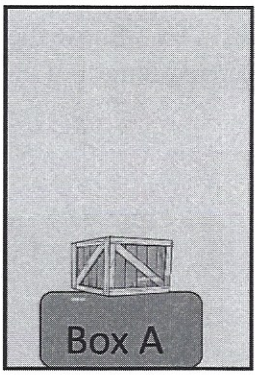
Something like that..

17) Determine the weight of a 15 kg object.

147 N

33 lb

18) Both box A and the wooden crate in the diagram are in an elevator (The shaded box). The wooden crate weighs 558 pounds, and box A weighs 498 pounds. Determine the force exerted on the wooden crate by Box A when the elevator accelerates upward at $2m/s^s$.



250 kg

558 lbs = 2455 N

$N = W + (250)(2\ m/s^2)$

either

2955 N

671 pounds

19) Determine the mass of a 165 pound person.

74.8kg

20) An incline is used to raise a 25 kg object to a height of 2.5 m. Determine the force needed to push the object up the hill assuming the object is on a cart with really good wheels (meaning they have such little friction that we can call them frictionless) if the length of the ramp is 25m.

24.5N

21) 1,200 watts are required for a go-cart to maintain a constant speed of 8m/s. Determine the total resistive forces acting on the go-cart.

$$P = \frac{W}{t} = \frac{F_x}{t} = F_x v$$

$$\frac{P}{v} = \frac{1200}{8\ m/s} : (150\ N)$$