Physics 3A SPRING 2020

VERSION: A

SEAT #:

NAME:

ID#:

SIGNATURE:

Disc. Time:

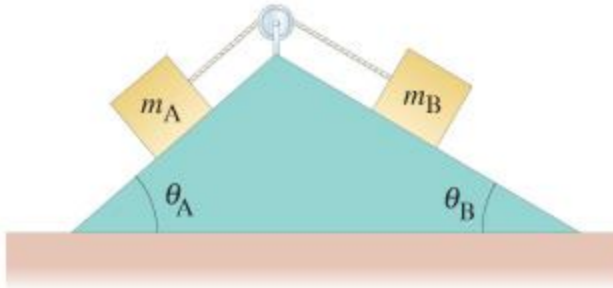
The exam will be 40 mins long. You may use a calculator but it CANNOT be a calculator with notes saved in it or connect to a phone line or internet. All items except your pencils, eraser, calculator and UCI ID, must be placed in a backpack or purse and left UNDER your seat or in FRONT of the classroom. You can tear off the formula sheet (the last page of your exam). No other notes are allowed. Once the exam begins, you must not talk to any other student until you leave the lecture hall.

For the 7 multiple choice Questions, circle the letter of the answer that you think is correct or that is closest to your calculation. For the 2 free response Problems, you must write the full solution (including all steps) to receive full credit. Please record your answers including key equations and steps to arrive at the final answer in the boxes provided. Only work *in the form or equivalent boxes drawn by you* will be graded for credit. If you need more room, you can make equivalent boxes on the back of the sheet. Unless otherwise noted, all numerical answers should be given to 2 significant digits and you need to give appropriate units. Good luck!

If you do not correctly follow all the instructions for the exam, including the instructions for handing in the exam, points will be deducted from your score or your exam will be nullified.

Midterm	score
Problem 1	
Problem 2	
Multiple Choice 1-6	
Multiple Choice 7-8	
Total	

Problem 1 (25 pts)



The masses m_A and m_B slide on the smooth (frictionless) inclines fixed as shown in the figure.

$\theta_A = 30°$, $\theta_B = 21°$, $m_A = 9.4$ kg , and $m_B = 4.5$ kg

Draw a free body diagram for block A and block B. Indicate your coordinate system for both diagrams.

What is the magnitude and direction of the acceleration?

What is the tension in the string?

Version A

Problem 2 (25 pts)

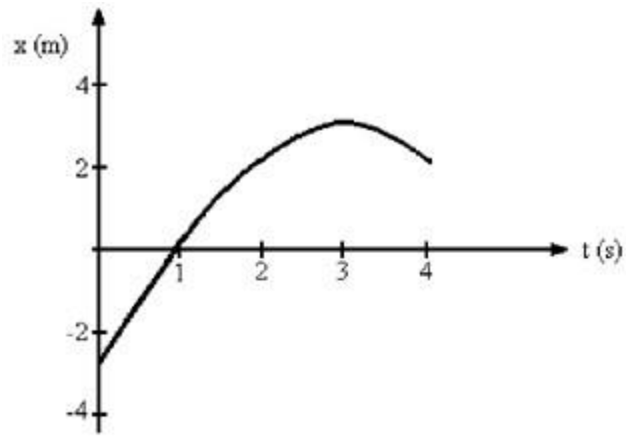
A person in the passenger basket of a hot-air balloon throws a ball horizontally outward from the basket with speed 10.0 m/s

What initial velocity (magnitude and direction) does the ball have relative to a person standing on the ground if the hot-air balloon is **dropping** at 4.0 m/s relative to the ground during this throw?

If the height of the balloon is 110 m at the moment the ball is thrown, how long will it take until the ball hits the ground?

Multiple choice questions (Questions 1-6 are worth 5 points each. Question 7-8 are worth 10 points each. Circle the correct answer – only one correct answer per question possible)

1. The figure on the right represents the position of a particle as it travels along the *x*-axis. What is the magnitude of the average velocity of the particle between t = 1 s and t = 4 s?



a) 0.25 m/s

b) 0.50 m/s

c) 0.67 m/s

d) 1.0 m/s

e) 1.3 m/s

2. Looking at the same figure, at what value of *t* is the speed of the particle equal to zero?

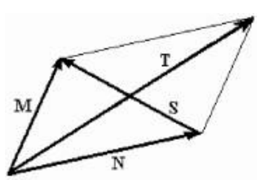
a) 1 s

b) 3 s

c) 2 s

d) 4 s

e) 0 s

3. 

Vector S as expressed in terms of vectors M and N is given by

a) M+N **b) M-N** **c) N-M** **d) M**

4. You drop a package from a plane flying at 200m/s. Immediately after the package is dropped, one of the engines fails and the plane slows down to 100m/s. The package will

a) lag behind the plane while falling

b) remain vertically under the plane while falling

c) move ahead of the plane while falling

d) impossible to tell

5. Raindrops make an angle θ=35 degrees with the vertical when viewed through a moving train window (see Figure).

If the speed of the train is v=56 miles/hour, what is the speed of the raindrops in the reference frame of the Earth in which they are assumed to fall vertically? Assume a value of g=10 m/s^2

a) 65 miles/hour

b) 70 miles/hour

c) 75 miles/hour

d) 80 miles/hour

e) 85 miles/hour

6. A block of mass m rests on the floor of an elevator that is moving upward at constant speed. What is the relationship between the force due to gravity and the normal force on the block?

a) N > mg

b) N = 0

c) N = mg

d) N < mg (but not zero)

e) depends on the size of the elevator

7. A rock is dropped from a vertical cliff. The rock takes 7.00 s to reach the ground below the cliff. What is the height of the cliff?

a) 240 m

b) 481 m

c) 80.1 m

d) 100 m

e) 26.2 m

8. Two objects are dropped from a bridge, an interval of 1.00 s apart. What is their separation 1.00 s after the second object is released?

a) 19.8 m

b) 14.7 m

c) 7.35 m

d) 4.90 m

e) 9.80 m

3A Formula Sheet

$\bar{v} = \frac{\Delta x}{\Delta t}$, $\bar{a} = \frac{\Delta v}{\Delta t}$

Basic 1D equations

$x = x_0 + v_0\, t + \frac{1}{2}\, at^2$

$v = v_0 + a\, t$

Derived 1D equations

$v^2 = v_0^2 + 2\, a\, (x - x_0)$

$\bar{v} = \dfrac{v + v_0}{2}$

Specific accelerations

g on earth near surface= 9.81 m/s^2

$a_R = \frac{v^2}{r}$

Newton's laws: $\sum \vec{F} = m\vec{a}$, $\overrightarrow{F_{AB}} = -\overrightarrow{F_{BA}}$

Friction force: $F_{fr} = \mu_k F_N$ or $F_{fr} = \mu_S F_N$ with F_N normal force, $\mu k < \mu S$ kinetic and static coefficient of friction (numbers will be given if needed)

Gravity: $F_G = mg$; General gravity:

$\vec{F}_{12} = -G\frac{m_1 m_2}{r_{12}^2}\, \hat{r}_{12}$, G = 6.67 x 10^{-11} Nm^2/kg^2

g = GM_P/r_P^2 for any planet or other celestial object

Spring: F_{el} = -k x ; k: spring constant

Work = $\int_a^b F\ \cos\theta\ dl$;

For constant force: W = F d cos θ

Kinetic energy: K = ½ mv^2

Potential energy due to gravity U_{gr} = mg h

Potential energy due to a spring U_{el} = ½ k x^2

A vector of magnitude V making an angle θ with the x axis has components

$V_x = V \cos\theta \quad V_y = V \sin\theta$

Given the components, magnitude and direction are

$V = \sqrt{V_x^2 + V_y^2} \qquad \tan\theta = \frac{V_y}{V_x}$

Scalar product of two vectors

$\vec{A}\vec{B} = AB\ \cos\theta = A_x B_x + A_y B_y + A_z B_z$

Linear momentum $\vec{p} = m\, \vec{v}$

Impulse – momentum theorem: $\overrightarrow{p_f} - \overrightarrow{p_i} = \int_{t_i}^{t_f} \vec{F} dt$

Momentum is conserved in any collision. In elastic collisions, kinetic energy is also conserved. In 1D elastic collisions, this means that relative velocities are conserved

Center of mass: $x_{CM} = \frac{\sum m_i x_i}{\sum m_i}$ (same for y and z)

Torque: $\tau = R_\perp F$ ($R_\perp$: lever arm). Generally, $\tau = R\ F\ \sin\theta$, where θ is the angle between R and F

Condition for static equilibrium:

$\sum F_x = 0, \sum F_y = 0, \sum F_z = 0, \ \sum \tau = 0$

Kepler's 3rd law:

$\frac{T^2}{r^3} = K_S = \frac{4\,\pi^2}{GM_{Sun}}$