KEY

PHYSICS 2110 – EXAM #1
February 19, 2013

SEAT NO.______________ **NAME (PRINT)**________________________

YOU MUST SHOW YOUR WORK AND EXPLAIN YOUR REASONING TO RECEIVE CREDIT. ALL CELL PHONES AND OTHER COMMUNICATION DEVICES MUST BE TURNED OFF AND STORED OUT OF SIGHT. NO EXTRA PAPERS ARE ALLOWED OTHER THAN THE PROVIDED FORMULA SHEET. STANDARD SCIENTIFIC CALCULATORS MAY BE USED.

You may ignore air resistance unless told otherwise.
Free-body diagrams are ***required*** for problems involving forces.

INSTRUCTORS (Circle ONE):	CLASS MEETING TIME
Shriner	8:00 AM
Kozub	9:05 AM
Kidd	10:10 AM
Murdock	11:15 AM
Ayik	1:25 PM

PROBLEM	POINT VALUE	YOUR SCORE
1	5	
2	15	
3	7	
4	6	
5	7	
6	15	
7	5	
8	7	
9	13	
10	10	
11	10	
TOTAL	100	

1. The figure shows the velocity-time graph for a particle moving on an x- axis. (1 pt each)

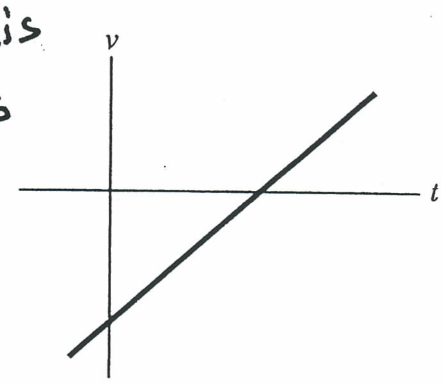
(a) What is the initial direction of travel? negative x-axis

(b) What is the final direction of travel? positive x-axis

(c) Does the particle stop momentarily during its trip? yes

(d) Is the acceleration positive or negative? positive

(e) Is the acceleration constant or varying? constant



A pitcher tosses a baseball up along a y-axis with an initial speed of 12 m/s.

(a) How long does the ball take to reach its maximum height? (5 pts)

$$V_y = V_{y_0} - g t \rightarrow \quad t = \frac{V_{y_0}}{g} = \frac{12}{9.8} = \boxed{1.2\ s}$$

(b) What is the maximum height of the ball above its release point? (5 pts)

$$V_y^2 = V_{y_0}^2 - 2g\, y_{max} = 0$$

$$y_{max} = \frac{V_{y_0}^2}{2g} = \frac{(12)^2}{2\times 9.8} = \boxed{7.3\ m}$$

(c) How long does the ball take to reach the point 5.0 m above its release point for the first time? (5 pts)

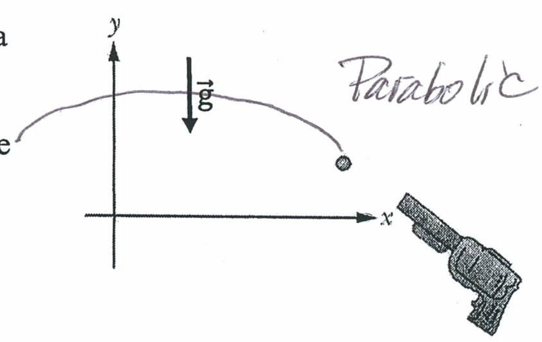
$$y = y_0 + V_{y_0} t - \frac{1}{2} g t^2$$

$$5 - 12t + 4.9t^2 =$$

$$t = \frac{12 \mp \sqrt{144 - 20\times 4.9}}{9.8}$$

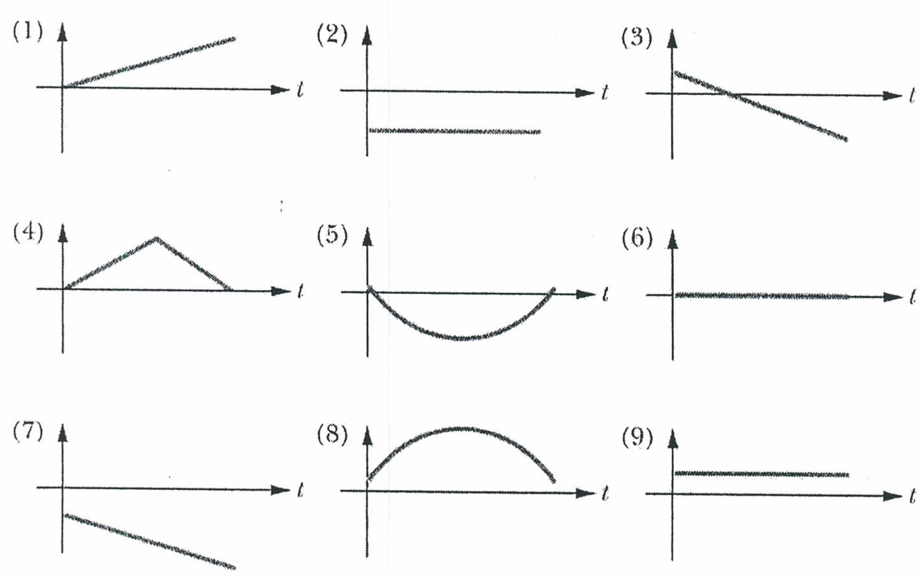
$$\boxed{t_{min} = 0.5\ s}$$

3. A popgun is angled so that it shoots a small dense ball through the air as shown at right. The picture also shows a pair of x-y axes.



(a) Sketch the path that the ball will follow on the figure to the right (1 pt)

For each of the graphs shown below, the horizontal axes represent time. The vertical axes are unspecified. For each quantity listed below the graphs, choose the number(s) of the graph(s) that could provide an appropriate graph of the quantity in question. If none of the graphs are appropriate, write "N". Take t = 0 to be the instant just after the ball leaves the popgun. (1 pt each)



(b) x-component of position 3

(c) y coordinate of position 8

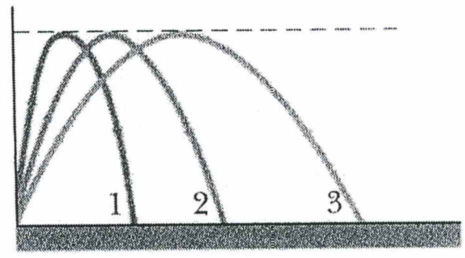
(d) x-component of velocity 2

(e) y-component of velocity 3

(f) x-component of acceleration 6

(g) y-component of acceleration 2

4. The figure to the right shows three paths for a stone thrown from ground level. Rank the three paths from least to greatest for each of the following quantities. Your answers must include an explanation. (1.5 pts each)



(a) Time in the air

Time in the air depends on maximum height $\Rightarrow t_1 = t_2 = t_3$

(b) Initial vertical component of velocity

Maximum heights depends on V_{oy} $\Rightarrow 1 = 2 = 3$

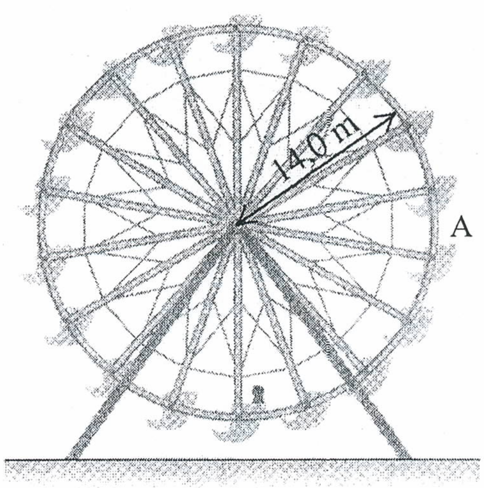
(c) Initial horizontal component of velocity

Same time in air, so farther horizontal distance $\Rightarrow$ greater V_{ox} $\Rightarrow 3 > 2 > 1$, So 1, 2, 3 from least to greatest

(d) Initial speed

Combine components from (b) and (c) $\Rightarrow 3 > 2 > 1 \Rightarrow$ 1, 2, 3 from least to greatest

5. Consider a Ferris wheel of radius 14.0 m. Suppose that once this ride is up to speed, the wheel turns in a clockwise direction, and a passenger moves at a constant speed of 6.5 m/s.



(a) What is the acceleration of a passenger with this speed when she is at position A, which is at a height equal to that of the center of the wheel? (4 pts)

$\vec{a} = \frac{v^2}{r}$ toward center

$= \frac{(6.5\,m/s)^2}{14.0\,m} \leftarrow \; = 3.0\,m/s^2 \leftarrow$

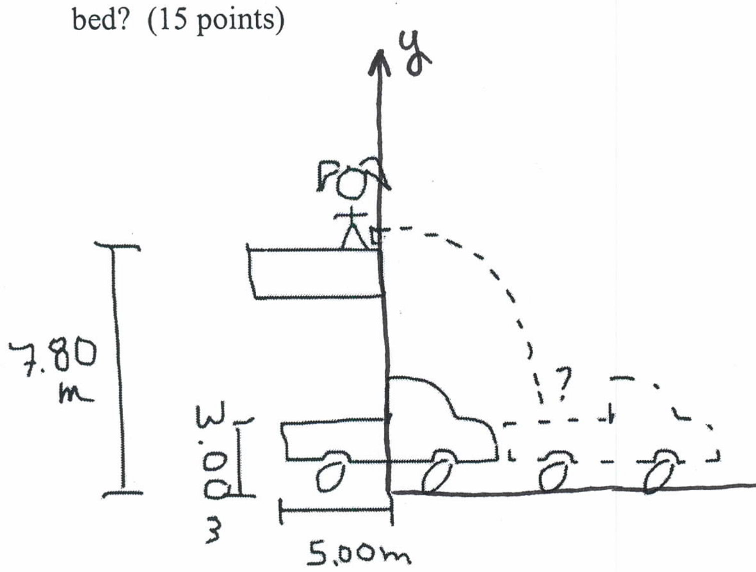
(b) As the ride comes to an end, the wheel starts slowing down. During this slowdown period, the rider reaches the lowest point of her path with a speed of 5.0 m/s. At this instant, she is losing speed at a rate of 0.50 m/s^2. What is her acceleration at this time? (3 pts)

$a_t = 0.50\,m/s^2$ to the right ($\vec{v}$ is left and speed is slowing)

$a_r = \frac{(5.0\,m/s)^2}{14.0\,m} \uparrow \; = 1.8\,m/s^2$ upward

$\vec{a}$ is a vector; I have given its components, so this is sufficient

6. A girl stands on a bridge 7.80 m high watching traffic pass by. She sees a pick-up truck traveling at a constant 31.3 m/s and decides to kick her can of soda into the back of the truck as it passes. She kicks the can horizontally with an initial velocity of 27.5 m/s the instant she sees the front of the bed of the truck. The truck bed is 5.00 m long, and 3.00 m from the ground. Does the can make it into the truck bed? (15 points)



can	truck
$x_0 = 0$	$x_0 = 0$
$x_f = ?$	$x_f = ?$
$y_0 = 7.80\,m$	$V_{0x} = 31.3\, m/s$
$y_f = 3.00\,m$	$a_x = 0\, m/s^2$
$V_{0x} = 27.5\, m/s$	
$V_{0y} = 0\, m/s$	
$a_x = 0\, m/s^2$	
$a_y = -9.8\, m/s^2$	

① Find time for can to fall:

$$y_f = y_0 + V_{0y}t + \frac{1}{2}a_y t^2$$

$$\sqrt{\frac{2(y_f - y_0)}{a_y}} = t$$

$$t = \sqrt{\frac{2(3.00m - 7.80m)}{(-9.8\, m/s^2)}}$$

$$t = 0.99\,s$$

② Where is can in x?

$$x_f = x_0 + V_{0x}t + \frac{1}{2}a_x t^2$$

$$x_f = 0 + (27.5\, m/s)(0.99s)$$

$$x_f = 27.2\,m$$

Can location is between 26.0m + 31.0m so can makes it!

③ Where is truck in x?

$$x_f = x_0 + V_{0x}t + \frac{1}{2}a_x t^2$$

$$x_f = 0 + (31.3\, m/s)(0.99s)$$

$x_f = 31.0\,m$ (front of bed)

Truck bed is between 26.0m and 31.0m

7. Perform the following operation with the vectors below. Be sure to show all your work! (5 pts)

$\vec{A} = 1.4\hat{i} + 4.6\hat{j} - 5.9\hat{k}$

$\vec{B} = -2.3\hat{j} - 1.6\hat{k}$

(a) $C = \vec{A} + 2\vec{B}$

$$\vec{A} = 1.4\hat{i} + 4.6\hat{j} - 5.9\hat{k}$$

$$2\vec{B} = 0\hat{i} + 2(-2.3)\hat{j} + 2(-1.6)\hat{k}$$

$$1.4\hat{i} + 0\hat{j} - 9.1\hat{k}$$

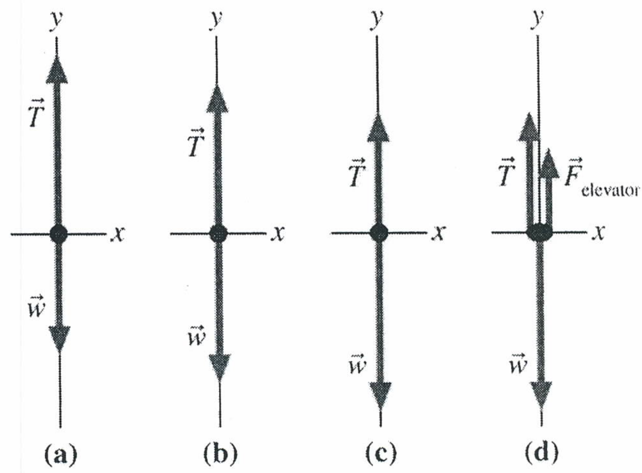
$$\vec{C} = 1.4\hat{i} - 9.1\hat{k}$$

(b) What is the magnitude of $\vec{C}$?

$$|\vec{C}| = \sqrt{(1.4)^2 + (-9.1)^2}$$

$$= 9.2$$

8. An elevator of weight $\vec{w}$ is suspended by a cable that provides tension $\vec{T}$. The elevator can move either upward or downward with no friction. For each case listed below, state which of the given free body diagrams *could* be correct. If none of the diagrams could be correct, write "None". (1 pt each)



1) The elevator is moving upward with increasing speed.

2) The elevator is moving downward with increasing speed.

3) The elevator is moving downward with decreasing speed.

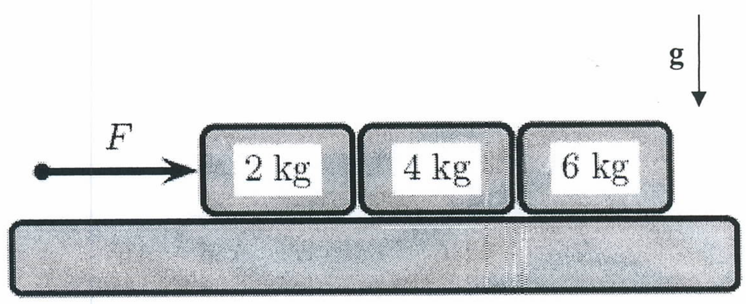
4) The elevator is moving upward with decreasing speed.

5) The elevator is moving upward at constant speed.

6) The elevator is moving downward at constant speed.

7) The elevator is at rest.

9. Three blocks of masses 2.00 kg, 4.00 kg, and 6.00 kg are in contact as shown on a frictionless horizontal surface. A 36.0 N horizontal force ***F*** is applied to the 2.00 kg block to the right as shown.

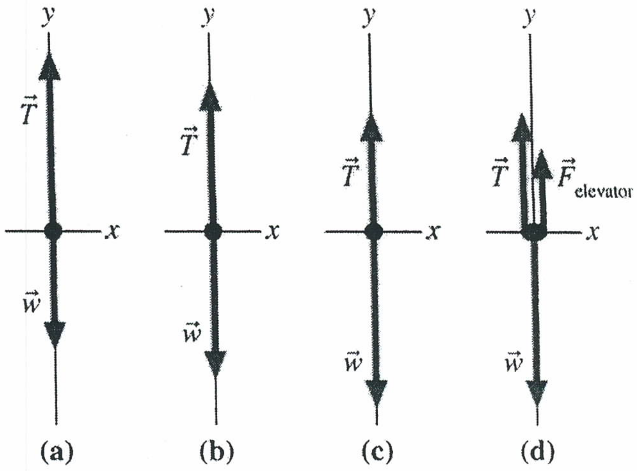


(a) Calculate the acceleration of the 6.00 kg block. (4 pts)

(b) Calculate the force the 4.00 kg block exerts on the 6.00 kg block. (3 pts)

(c) Calculate the force the 2.00 kg block exerts on the 4.00 kg block. Explain fully. (6 pts)

8. An elevator of weight $\vec{w}$ is suspended by a cable that provides tension $\vec{T}$. The elevator can move either upward or downward with no friction. For each case listed below, state which of the given free body diagrams *could* be correct. If none of the diagrams could be correct, write "None". (1 pt each)



1) The elevator is moving upward with increasing speed. a

2) The elevator is moving downward with increasing speed. c

3) The elevator is moving downward with decreasing speed. a

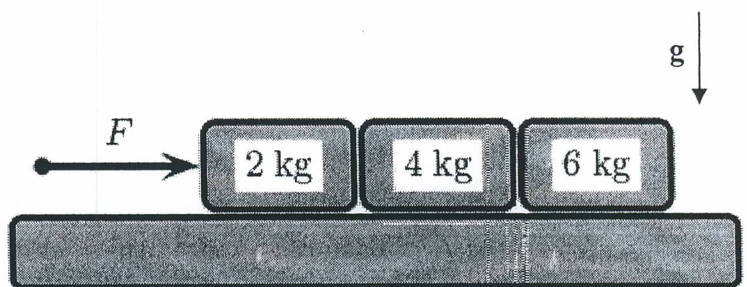
4) The elevator is moving upward with decreasing speed. c

5) The elevator is moving upward at constant speed. b

6) The elevator is moving downward at constant speed. b

7) The elevator is at rest. b

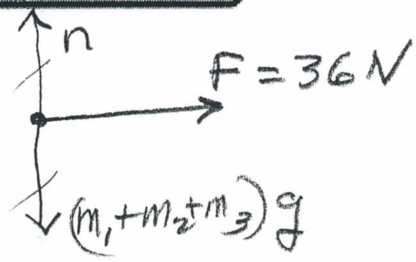
9. Three blocks of masses 2.00 kg, 4.00 kg, and 6.00 kg are in contact as shown on a frictionless horizontal surface. A 36.0 N horizontal force F is applied to the 2.00 kg block to the right as shown.



(a) Calculate the acceleration of the 6.00 kg block. (4 pts)

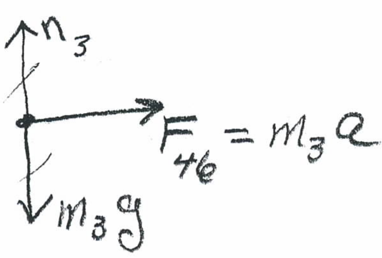
$F_{net} = F = (m_1 + m_2 + m_3)a$

$a = \frac{36\ N}{(2+4+6)\ kg} = 3.00 \frac{m}{s^2}$ for all blocks



(b) Calculate the force the 4.00 kg block exerts on the 6.00 kg block. (3 pts)

$F_{46} = m_3 a = (6.\ kg)(3 \frac{m}{s^2}) = 18.0\ N$



(c) Calculate the force the 2.00 kg block exerts on the 4.00 kg block. Explain fully. (6 pts)

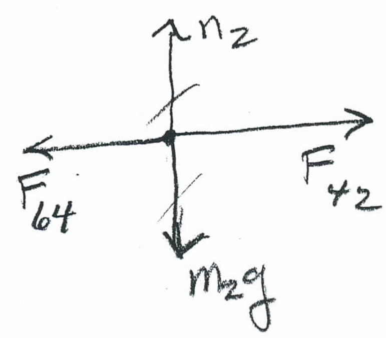
$F_{64} = F_{46}$ via Newton's 3rd Law

FBD for $m_2 = 4\ kg$

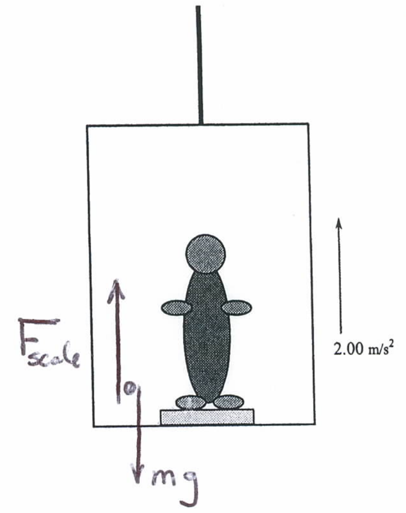
$F_{42} - F_{64} = m_2 a$

$F_{42} = F_{64} + m_2 a = 18N + 4\ kg(3 \frac{m}{s^2})$

$F_{42} = 30.0\ N$



10. A man stands on a scale inside an elevator which is accelerating upward at 2.00 $\frac{m}{s^2}$. The scale reads 1420 N.



(a) What is the mass of the man? (6 pts)

Forces on man are F_{scale} (up) and weight mg down. With +y = "up", his acceleration is $a_y = +2.00\ \frac{m}{s^2}$. N's 2nd law gives

$$\Sigma F_y = F_{scale} - mg = ma_y$$

$$F_{scale} = mg + ma_y = m(g+a_y)$$

$$\rightarrow m = \frac{F_{scale}}{(g+a_y)} = \frac{1420\text{ N}}{(9.80\frac{m}{s^2} + 2.00\frac{m}{s^2})} = \boxed{120\text{ kg}}$$

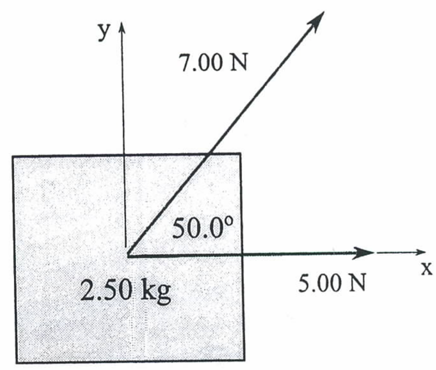
(b) What would the scale read if the elevator were descending at a constant speed of 3.50 m/s? (4 pts)

If the elevator is <u>not</u> <u>accelerating</u>, the net force on the man is zero:

$$F_{scale} - mg = 0 \quad \longrightarrow \quad F_{scal} = mg = (120\text{ kg})(9.8\ \tfrac{m}{s^2})$$
$$= 1180\text{ N}$$

Scale reads $\boxed{1.18 \times 10^3\text{ N}}$

11. Two forces act on a 2.50 kg mass as shown. (A 5.00 N force acts in the +x direction; a 7.00 N force acts at 50.0° from the +x axis; both act in the xy plane.) These are the only two forces acting on the mass!



Find the acceleration of the mass (i.e., give its magnitude and direction). (10 pts)

$$\Sigma F_x = 5.00\text{ N} + (7.00\text{ N})\cos 50° = 9.50\text{ N} = ma_x$$

$$\rightarrow a_x = \frac{9.50\text{ N}}{2.50\text{ kg}} = 3.80\ \frac{m}{s^2}$$

$$\Sigma F_y = (7.00\text{ N})\sin 50° = 5.36\text{ N} = ma_y$$

$$a_y = \frac{5.36\text{ N}}{2.50\text{ kg}} = 2.14\ \frac{m}{s^2}$$

$$a = \sqrt{a_x^2 + a_y^2} = \boxed{4.36\ \frac{m}{s^2}}$$

Dir of $\vec{a}$: $\tan\theta = \frac{a_y}{a_x} = 0.563 \Rightarrow \boxed{\theta = 29.4°}$