PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Fall Semester 2014**

College of Arts and Sciences

Section **Quiz 2-1** **October 2014**

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

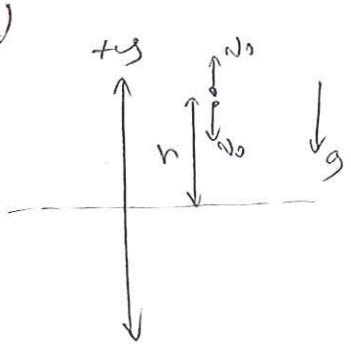
An object held at a height h meters above the ground explodes in two pieces which move with equal speeds v_0 but in opposite directions vertically. The gravitational acceleration is g.

a) [10 pts] Sketch the initial configuration of the problem.(Draw coordinate system, positions, velocities etc. on your sketch.)

b) [40 pts] Show that the time interval between the respective instants the pieces hit the ground does not depend on the initial height, h, of the object.

c) [50 pts] Take $h = 10m$, $v_0 = 5\,m/s$, $g = 10\,m/s^2$. Draw the velocity-time graph of the pieces until both of them hit the ground, on the same figure.

a)



b) $y - y_0 = v_0 t + \frac{1}{2} a t^2$

For upward moving piece $-h = v_0 t_1 - \frac{1}{2} g t_1^2$

For downward moving piece $-h = -v_0 t_2 - \frac{1}{2} g t_2^2$

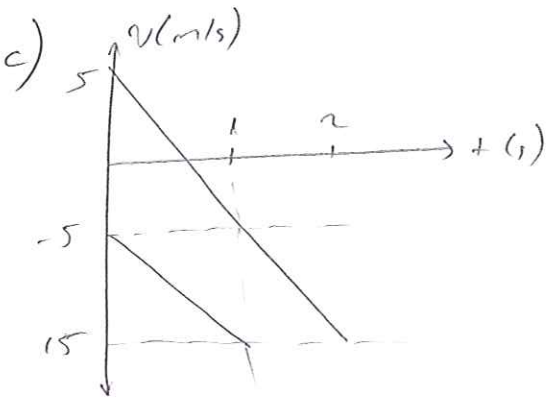
$$v_0 t_1 - \frac{1}{2} g t_1^2 = -v_0 t_2 - \frac{1}{2} g t_2^2$$

$$v_0 (t_1 + t_2) = \frac{1}{2} g (t_1^2 - t_2^2)$$

$$v_0 (t_1 + t_2) = \frac{1}{2} g (t_1 - t_2)(t_1 + t_2)$$

$$\boxed{t_1 - t_2 = \frac{2 v_0}{g}}$$

c)



PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Fall Semester 2014**

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Section **Quiz 2-2** **October 2014**

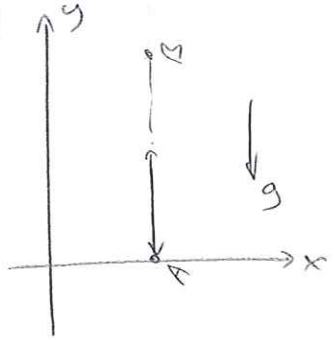
Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A particle A is thrown vertically upward from the ground with initial speed v_0. At the same instant, another particle B is thrown vertically (direction unknown) from a height above A. Both particles reach to the ground at the same time. Gravitational acceleration is g.

a) [10 pts] Sketch the initial configuration of the problem.(Draw a coordinate system, positions, velocities etc. on your sketch.)
b) [40 pts] If the maximum throwing speed of B can be $v_0/3$ determine the maximum height from which it can be thrown.
c) [50 pts] If particle B is thrown from the height determined in part (b), calculate its position when particle A reaches to its maximum height. Show this position and the initial positions of the particles on the position-time graph qualitatively.

a)



b) $y - y_0 = v_0 t - \frac{1}{2} g t^2$

$0 = v_0 t - \frac{1}{2} g t^2 \Rightarrow t = \frac{2v_0}{g}$

For the maximum height B must be thrown vertically.

$y - y_0 = \frac{-v_0}{3} t - \frac{1}{2} g t^2$

$-h = \frac{-v_0}{3} t - \frac{1}{2} g \frac{4v_0^2}{g^2}$

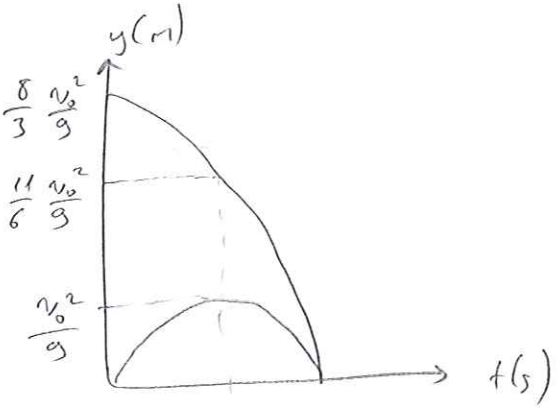
$h = \frac{2v_0^2}{3g} + \frac{2v_0^2}{g} = \frac{8v_0^2}{3g}$

c) A reaches maximum point at

$t = \frac{v_0}{g}$

$y - y_0 = -\frac{v_0}{3} \cdot \frac{v_0}{g} - \frac{1}{2} g \frac{v_0^2}{g^2}$

$y = \frac{11}{6} \frac{v_0^2}{g}$



PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Fall Semester 2014**

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Section **Quiz 2-3** **October 2014**

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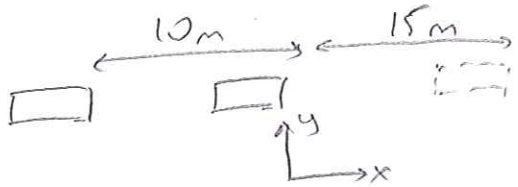
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

Suppose that while driving on the road to the university, you attempt to take over a car which is moving with constant speed $v_0 = 40km/h$ ahead of you. Your car's initial speed is the same. You start the takeover maneuver 10m behind the car by applying a constant acceleration of $2m/s^2$ and complete it 15m ahead of the car, where you stop accelerating and move with your final constant speed.

a) [10 pts] Sketch the initial configuration of the problem. .(Draw coordinate system, positions, velocities etc. on your sketch.)
b) [40 pts] Calculate the total distance your car travels to complete the maneuver from where it has started.
c) [50 pts] Plot the position-time graph of the two cars on the same figure. Take your car's position as the origin and indicate the time coordinate where both cars are moving side by side. Also show the distances given in the question and calculated in part (b) on the graph.

a)



Coordinate axis is fixed on the car.

b) $x - x_0 = v_0 t + \frac{1}{2} a t^2$

$25 = \frac{1}{2} \cdot 2 t^2 \Rightarrow t = 5$

In 5s, the coordinate system moves

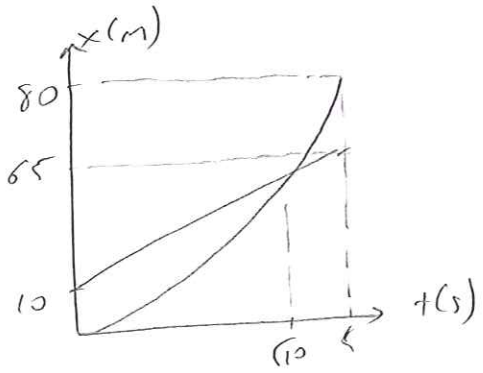
$v_0 t = \frac{40000}{3600} \cdot 5 = \frac{500}{9} m \cong 55m$

Total distance travelled is

$x_T = 55m + 25m = 80m$

c) $10 = v_0 t + \frac{1}{2} a t^2$

$10 = \frac{1}{2} \cdot 2 \cdot t^2 \Rightarrow t = \sqrt{10}$



PHYS 101: General Physics 1 **KOÇ UNIVERSITY** **Fall Semester 2014**

College of Arts and Sciences

Section **Quiz 2-4** **October 2014**

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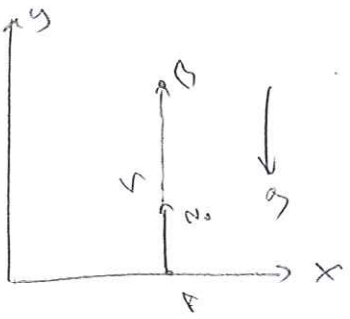
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A particle A is thrown vertically upward from the ground with initial speed v_0. At the same instant, another particle B is thrown vertically upward from a height above A. Both particles reach to the ground at the same time. Gravitational acceleration is g.

a) [10 pts] Sketch the initial configuration of the problem. .(Draw coordinate system, positions, velocities etc. on your sketch.)
b) [40 pts] Find the maximum height the particle B can reach if its initial speed is $v_0/2$.
c) [50 pts] Take $v_0 = 10\ m/s,\ g = 10 m/s^2$. Draw the position-time graph of both particles on the same figure. Show their initial positions, the maximum height they reach, and the times they hit the ground qualitatively.

a)



b) $y - y_0 = v_0 t - \frac{1}{2} g t^2$

$\frac{1}{2} g t^2 = v_0 t \rightarrow t = \frac{2v_0}{g}$ ✓

Time it takes for A to hit the ground.

$y - y_0 = \frac{v_0}{2} \cdot \frac{2v_0}{g} - \frac{1}{2} g \frac{4v_0^2}{g^2}$

$-h = \frac{2v_0}{g} - \frac{2v_0^2}{g}$

$h = \frac{v_0^2}{g}$

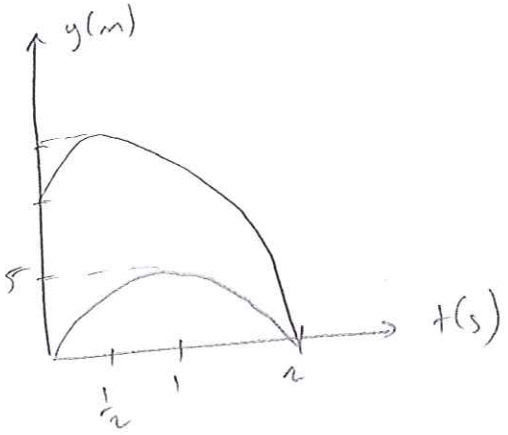
c) $v = v_0 - gt$

$0 = \frac{v_0}{2} - gt \Rightarrow t = \frac{v_0}{2g}$

Time it takes for b to reach maximum.

$y - \frac{v_0^2}{g} = \frac{v_0}{2} \cdot \frac{v_0}{2g} - \frac{1}{2} g \frac{v_0^2}{4g}$

$y = \frac{9}{8} \frac{v_0^2}{g}$



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Section **Quiz 2-5** **October 2014**

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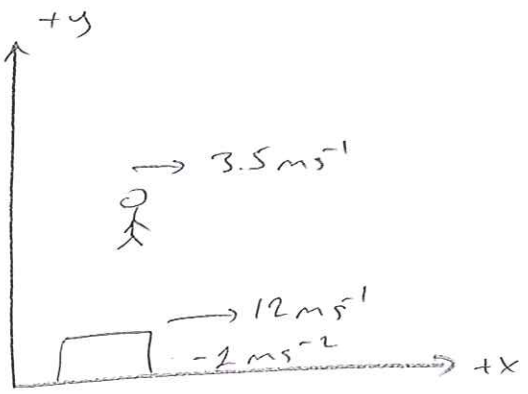
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A student is running with his maximum speed of 3.5 m/s towards the bus station. The shuttle bus passes by the student with 12 m/s and at the same instant slows down with uniform acceleration of $2m/s^2$ to stop by the station. The bus waits 5 seconds at the station and then departs with a constant acceleration $2m/s^2$.

a) [10 pts] Sketch the problem at the instant the bus is passing by the student. .(Draw coordinate system, positions, velocities etc. on your sketch.)
b) [50 pts] Draw the velocity versus time graph of the student and the shuttle bus from the moment when the bus was passing by the student.
c) [40 pts] Determine whether the student catches the bus. If yes, where?

a)



c) $\frac{36m}{3.5ms^{-1}} \cong 10s$

The student reaches the bus before it moves again

b)