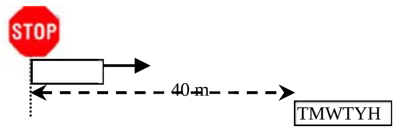
University Physics 1 – Fall 2011 – Test 1 Name ____

09/15/11 ***Curious George and the …*** Choose **4** out of 5 problems Banner ________________

1) *Curious George and the Speeder.* Curious George (CG) is in the jeep with The Man with the Yellow Hat (TMWTYH). TMWTYH has the traffic enforcement job at the zoo, so he has to monitor speeders. He is parked by the side of the road, with a Stop sign **40 meters** behind him. He sees a speeder (coming toward him {to the right in the picture} with a speed of **20 m/sec**) blow through the stop sign, and TMWTYH starts accelerating (at the instant the speeder passes the stop sign) to be able to catch up to the speeder.



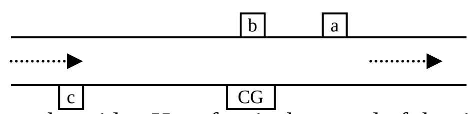
a) TMWTYH uses an acceleration of **3 m/s^2**, starting from rest. Find both locations where the two cars pass each other.

b) The next day, the same thing happens – except, TMWTYH uses the *perfect acceleration* so that he and the speeder **just pass each other once**. Calculate that acceleration. Also, find the distance (from the stop sign) where that passing point will occur.

c) Compare your answers (acceleration and distance) in B) to the values in A) – explain why the answers to B) are reasonable.

2) *Curious George and all the conceptual questions.* [If false, you need to explain why – or a counter argument.]
a) With a **positive** velocity and a **negative** acceleration, you can still be *speeding up* – true or false?
b) An object can have a **constant** speed, while at the same time having a *changing* velocity – true or false?
c) From the time you leave your room in the morning, until the time you get back to your room again – which is greater, your **distance** or your **displacement** - explain?
d) An object starts with a given initial speed, and slows to a stop in a time T. If the initial speed were **doubled**, but you stopped in the *same amount of time*, you would need **twice** the acceleration – true or false?
e) An object starts with a given initial speed, and slows to a stop in a distance D. If the initial speed were **doubled**, but you stopped in *the same distance*, you would need **twice** the acceleration – true or false?

3) *Curious George and the boat trip on the river.* The jungle river has a width of **20 meters**. CG has a boat that can travel at a speed of **8 m/sec** in still water. (Docks for following situations labeled in the diagram {***not to scale!***}.)



a) He aims the boat *directly across* the river, and ends up **14 meters** down river on the other side. How fast is the speed of the river?
b) George comes back over to the original side and decides he wants to *move in a line directly across the river* to the far shore – calculate the angle he should use to aim the boat? And, calculate how long it will take him to get across the river.
c) Instead of going across the river – George goes upstream to another dock, and then back down to his starting point (all this happens on the same side of the river). The whole trip takes 120 seconds … what is the distance between the two docks?

4) *Curious George and the flinging of the marshmallows off the cliff.* CG is on the top of a cliff and throws a marshmallow with a speed of **20 m/s** at an angle of **60 degrees** *above* the horizontal out over the plane. The marshmallow takes **5 seconds** to reach the ground below.

a) How high is the cliff?

b) How high **above the top of the cliff** does the marshmallow reach at the highest point of its flight?

c) What was the speed of the marshmallow when it hit the ground – and what is the angle of impact?

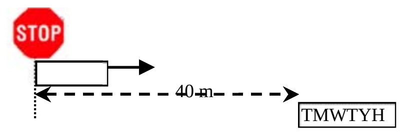
5) *Curious George and the long-delayed feeding time.* It is finally time to feed CG and he is in a tree **5 meters** off the ground. TMWTYH is standing **3 meters** from base of the tree (with his marshmallow launching gun on the ground, with a remote control trigger {so, we can consider the marshmallow fires up at an angle *from the ground*}). CG is going to let go of the branch when he hears the gun fire.

a) What angle should the gun be aimed to be able to feed CG in this scenario?
b) What **minimum launch speed** is needed to *just barely* feed CG - have the marshmallow hit him - before he hits the ground?
c) Suppose the gun uses a launch speed of **twice** that minimum … how high off the ground will CG be fed?
d) Describe (conceptually) what would happen if the launch speed were **half** of the minimum?

University Physics 1 – Fall 2011 – Test 1 SOLUTION KEY

09/15/11 ***Curious George and the …*** Choose **4** out of 5 problems

1) *Curious George and the Speeder.* Curious George (CG) is in the jeep with The Man with the Yellow Hat (TMWTYH). TMWTYH has the traffic enforcement job at the zoo, so he has to monitor speeders. He is parked by the side of the road, with a Stop sign **40 meters** behind him. He sees a speeder (coming toward him {to the right in the picture} with a speed of **20 m/sec**) blow through the stop sign, and TMWTYH starts accelerating (at the instant the speeder passes the stop sign) to be able to catch up to the speeder.



a) TMWTYH uses an acceleration of **3 m/s²**, starting from rest. Find both locations where the two cars pass each other.

b) The next day, the same thing happens – except, TMWTYH uses the *perfect acceleration* so that he and the speeder **just pass each other once**. Calculate that acceleration. Also, find the distance (from the stop sign) where that passing point will occur.

c) Compare your answers (acceleration and distance) in B) to the values in A) – explain why the answers to B) are reasonable.

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217 m

2) *Curious George and all the conceptual questions.* [If false, you need to explain why – or a counter argument.]

a) With a **positive** velocity and a **negative** acceleration, you can still be *speeding up* – true or false?

b) An object can have a **constant** speed, while at the same time having a *changing* velocity – true or false?

c) From the time you leave your room in the morning, until the time you get back to your room again – which is greater, your **distance** or your **displacement** - explain?

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d) An object starts with a given initial speed, and slows to a stop in a time T. If the initial speed were **doubled**, but you stopped in the *same amount of time*, you would need **twice** the acceleration – true or false?

: $v_0 \propto at$

e) An object starts with a given initial speed, and slows to a stop in a distance D. If the initial speed were **doubled**, but you stopped in *the same distance*, you would need **twice** the acceleration – true or false?

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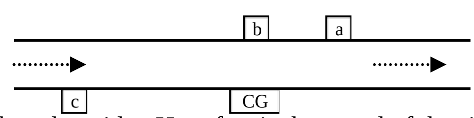
3) *Curious George and the boat trip on the river.* The jungle river has a width of **20 meters**. CG has a boat that can travel at a speed of **8 m/sec** in still water. (Docks for following situations labeled in the diagram {***not to scale!***}.)



a) He aims the boat *directly across* the river, and ends up **14 meters** down river on the other side. How fast is the speed of the river?

b) George comes back over to the original side and decides he wants to *move in a line directly across the river* to the far shore – calculate the angle he should use to aim the boat? And, calculate how long it will take him to get across the river.

Use 8 m/s as the hypotenuse and 5.6 as the far side : $\theta_{upstream} = \sin^{-1}\left(\frac{5.6}{8}\right) = 44.4^0$

Find velocity across : $v_{across} = \sqrt{8^2 - 5.6^2} = 5.7\ m/s \qquad t_{across} = \frac{20}{5.7} = 3.5\,\text{sec}$

c) Instead of going across the river – George goes upstream to another dock, and then back down to his starting point (all this happens on the same side of the river). The whole trip takes 120 seconds … what is the distance between the two docks?

$$t_{up} + t_{down} = 120 = \frac{x}{(8-5.6)} + \frac{x}{(8+5.6)} = x(0.417 + 0.74) \qquad x = 245\ m$$

4) *Curious George and the flinging of the marshmallows off the cliff.* CG is on the top of a cliff and throws a marshmallow with a speed of **20 m/s** at an angle of **60 degrees** *above* the horizontal out over the plane. The marshmallow takes **5 seconds** to reach the ground below.

a) How high is the cliff?

Use y equation : $0 = y_0 + (20\sin(60))(5) + (1/2)(-9.8)(5)^2 \qquad y_0 = 35.9\ m$

b) How high **above the top of the cliff** does the marshmallow reach at the highest point of its flight?

Time to top: $t_{top} = \frac{20\sin 60}{9.8} = 1.77\,\text{sec} \quad y_{top} = \frac{1}{2}(9.8)(1.77)^2 = 15.3m$ above the top of the cliff ..

As a check of part a … drop the marshmallow the rest of the time ..

$y_{down} = 4.9(5-1.77)^2 = 51.1m \qquad (51.1 - 15.3 \approx 35.9m \quad \text{cliff height})$

c) What was the speed of the marshmallow when it hit the ground – and what is the angle of impact?

$v_y = 20\sin 60 - (9.8)(5) = 17.32 - 49 = -31.7m/s \qquad v_x = 20\cos 60 = 10m/s$

$v_f = \sqrt{31.7^2 + 10^2} = 33.2\ m/s \qquad \theta_f = \tan^{-1}\left(\frac{31.7}{10}\right) = 72.5^0$ South of East

5) *Curious George and the long-delayed feeding time.* It is finally time to feed CG and he is in a tree **5 meters** off the ground. TMWTYH is standing **3 meters** from base of the tree (with his marshmallow launching gun on the ground, with a remote control trigger {so, we can consider the marshmallow fires up at an angle *from the ground*}). CG is going to let go of the branch when he hears the gun fire.

a) What angle should the gun be aimed to be able to feed CG in this scenario?

Aim at CG : $\theta_{aim} = \tan^{-1}\left(5/3\right) = 59^0$

b) What **minimum launch speed** is needed to *just barely* feed CG - have the marshmallow hit him - before he hits the ground?

Using the range equation: $R = 3 = \frac{v_0^2 \sin 2\theta}{g} = \frac{v_0^2 \sin 2(59)}{9.8} \qquad v_{min} = 5.77\ m/s$

c) Suppose the gun uses a launch speed of **twice** that minimum … how high off the ground will CG be fed?

Find time to tree: $t = \frac{3}{(2)(5.77)\cos(59)} = 0.5\ \text{sec} \qquad y_{cg} = 5 - 4.9(0.5)^2 = 3.775\ m$

d) Describe (conceptually) what would happen if the launch speed were **half** of the minimum?

The marshmallow doesn't have enough launch velocity to make it to the tree before CG hits the ground (and the marshmallow will hit the ground somewhere between the gun and CG). IF the marshmallow could slice through the ground, and if CG could burrow through the ground – the two would meet up somewhere underneath the base of the tree (that is, if you solve the equations for their intersection, you will get an answer – but the height from the base of the tree will be negative, meaning underground).