Name: KEY Period:

AP Motion Recitations Part1

1. A place-kicker must kick a football from a point 36.0 m (about 40 yards) from the goal, and half the crowd hopes the ball will clear the crossbar, which is 3.05 m high. When kicked, the ball leaves the ground with a speed of 20.0 m/s at an angle of 53.0° to the horizontal. Use $g = 10 m/s^2$

(a) How long is the ball in the air until it reaches the plane of the goal?

$\Delta X_{\text{to goal}} = 36m$

$V_{0x} = V_0 \cos\theta$

$V_{0x} = (20 m/s)\cos(53°) = 12.04 m/s$

x-axis

$\Delta X = V_{0x} \cdot t$

$t = \frac{\Delta X}{V_{0x}} = \frac{36m}{12.04 m/s} = \boxed{2.99 s}$

(b) By how much does the ball clear or fall short of clearing the crossbar?

Find the height of the ball at $t = 2.99 s$

y-axis

$\Delta y = V_{0y} t - \frac{1}{2} g t^2$

$V_{0y} = V_0 \sin\theta$

$V_{0y} = (20 m/s)\sin(53°) = 15.97 m/s$

$\Delta y = \left[15.97 m/s (2.99 s) - \frac{1}{2}(10)(2.99 s)^2\right]$

$\Delta y = 3.05m$ ← this is the ball's height @ $t = 2.99 s$

$3.05_m - 3.05_m = \emptyset$ - hits the crossbar

(c) Does the ball approach the crossbar while still rising or while falling? Explain.

y-axis

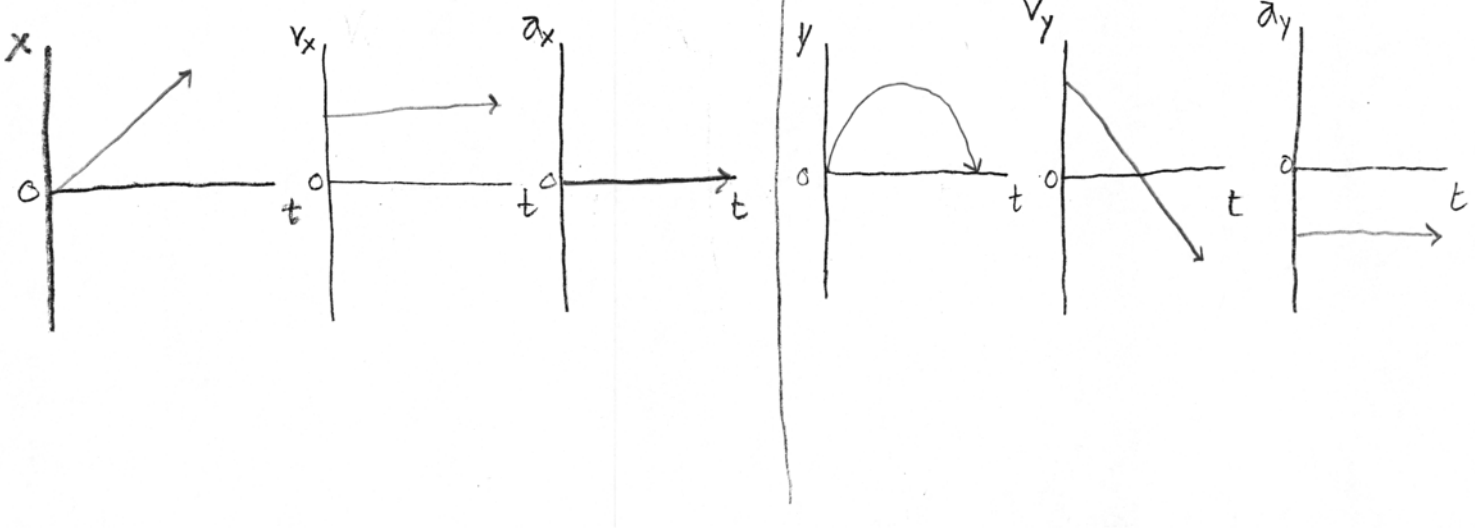
$V_y = V_{oy} - g t$

$V_y = (15.97 m/s) - (10)(2.99)$

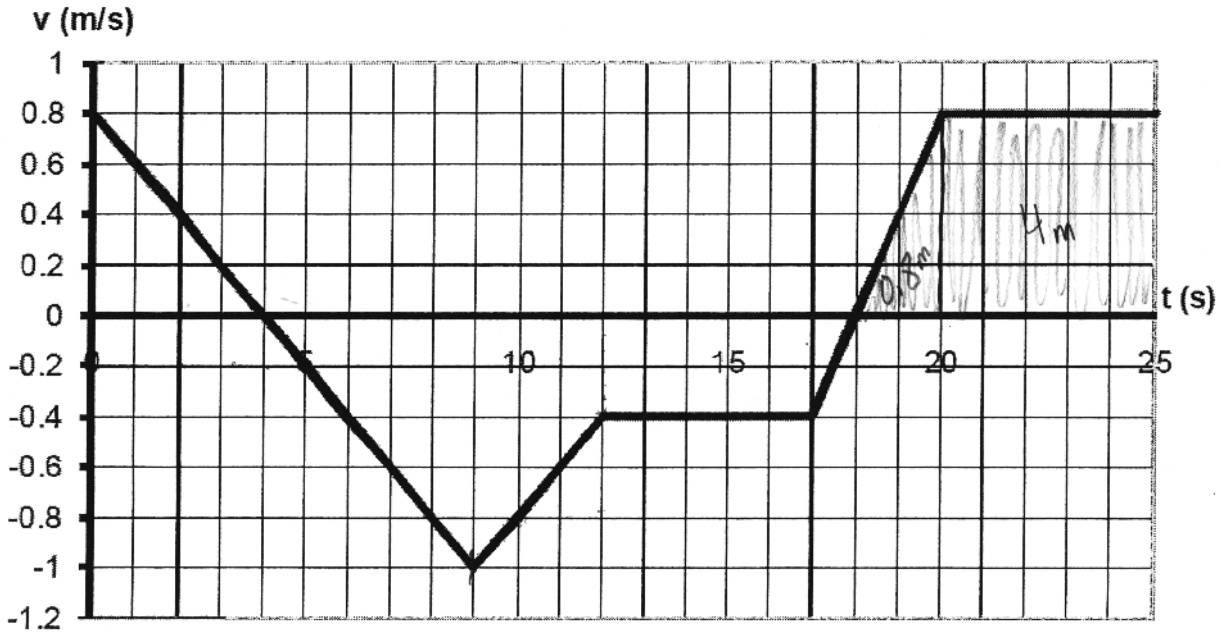
$V_y = -13.93 m/s$

falling, when you solve for the vertical velocity at the time of the crossbar it is negative. The ball is already on it's way down.

d) Sketch the following graphs of the object's motion.



2. A particle moves on a straight horizontal track. The graph of velocity v versus time t for the particle is given below.



a. Indicate every time t for which the particle is at rest.

$t = 4s$ $t = 18s$

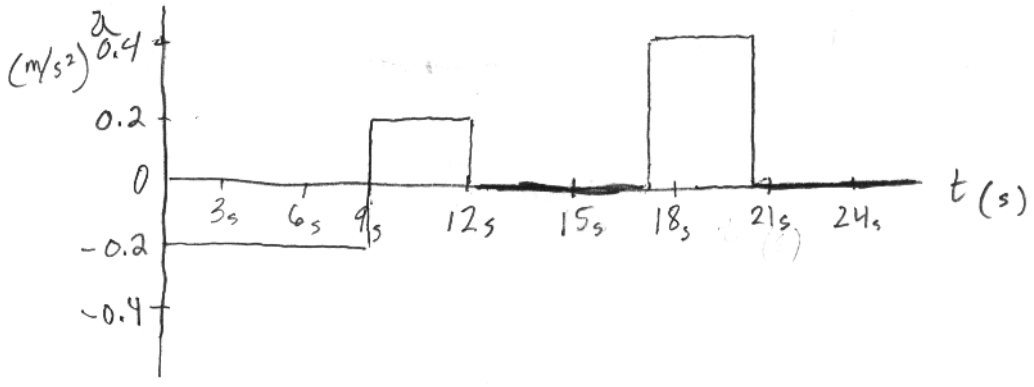
b. Indicate every time interval for which the speed (magnitude of velocity) of the particle is increasing.

$4-9s$, $18-20s$

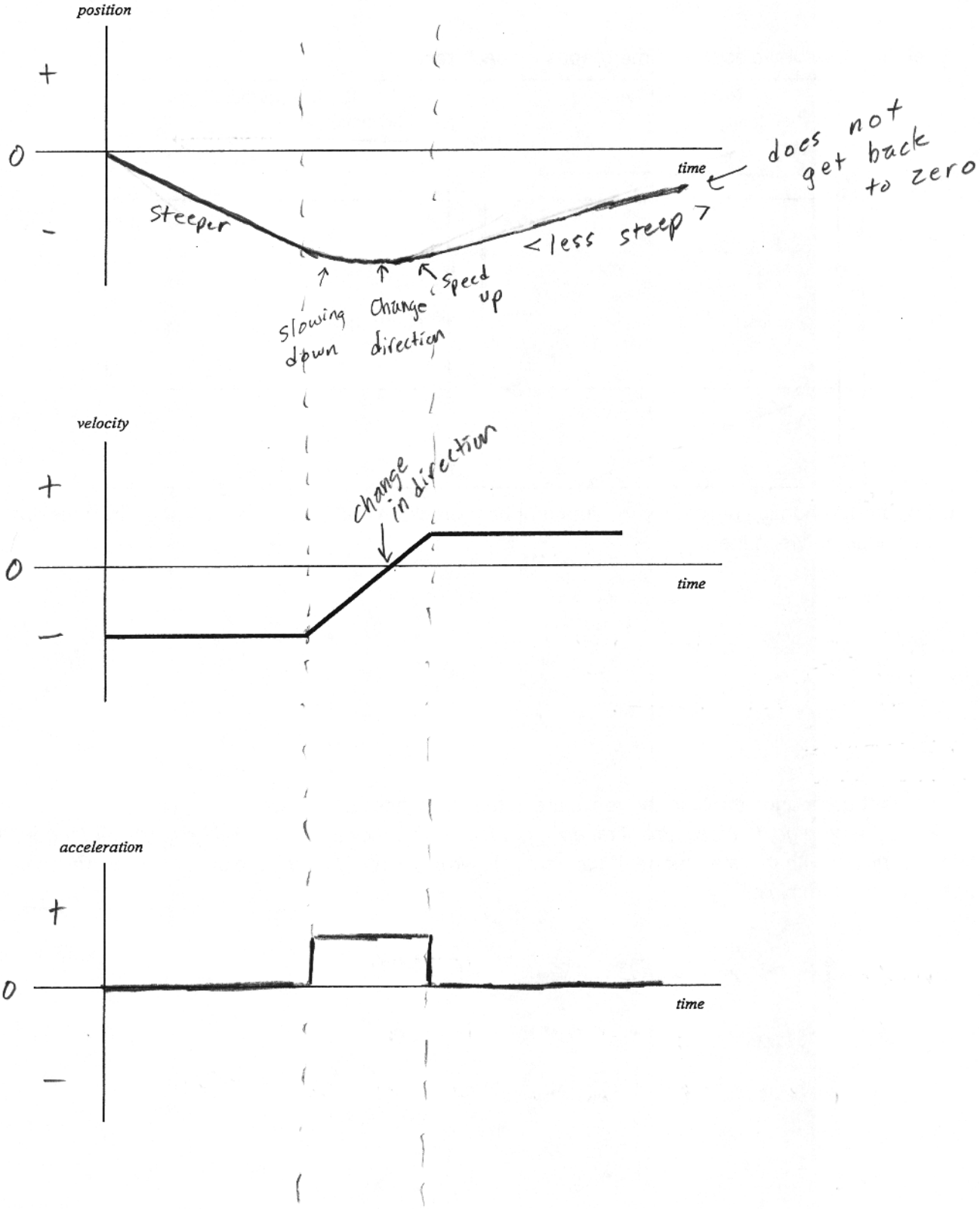
c. Determine the displacement of the particle during the time interval from t=18s to t=25s. The area under the slope is the displacement.

$\Delta X = 4.8m$

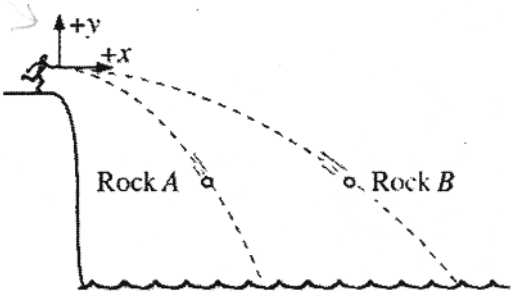
d. Sketch an acceleration versus time graph for the motion of the cart from t=0 to t=25s.



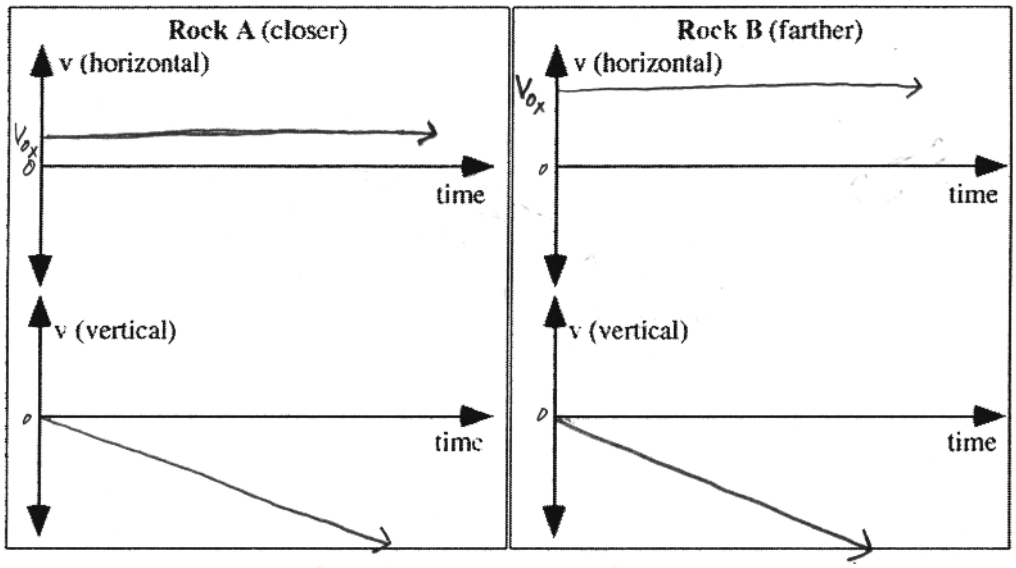
3. Sketch accurate schematic position *vs.* time and acceleration *vs.* time diagrams for the velocity *vs.* time diagram shown in the middle panel below. Assume that, at $t = 0$, the position of the object described is $x = 0$. Your functions need not be continuous.



Two students throw two rocks horizontally from a cliff with different velocities. Rock B hits farther from the base of the cliff. Use coordinates where up is the positive direction, away from the cliff is the positive horizontal direction, and the origin is at the top of the cliff at the point of release.



A. Sketch below the velocity vs. time graphs for each rock.



B. Compare the horizontal velocity vs. time graphs for rocks A and B, and explain any similarities or differences between them.

- A similarity is that both the horizontal velocities are constant due to zero acceleration on the horizontal.
- A difference is the magnitude of Rock B's velocity is greater. This is apparent due to the fact that its horizontal displacement is greater.

C. A student comparing the time the rocks are in the air in these cases states:

"*The faster you go, the less time it takes to get there. The rock in case A will be in the air longer.*" What if anything, is wrong with this statement? If something is wrong, identify it and explain how to correct it. If the statement is correct, explain why.

The student's statement is wrong in that rock A will not be in the air longer.

Both rocks have the same initial vertical velocity and experience the same vertical acceleration of $-10 m/s^2$ regardless of mass. This means that if they start at the same height they will hit the water at the same time. Rock B does have a greater horizontal velocity and therefore displaces horizontally more in the same amount of time.