Name: KEY

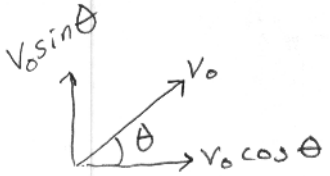
1

Period: _____

AP[redacted] Recitations Part 2

1. A place-kicker must kick a football from a point 25.0 m from the goal, and half the crowd hopes the ball will clear the crossbar, which is 8.0 m high. When kicked, the ball leaves the ground with a speed of 20.0 m/s at an angle of 48.0° to the horizontal.

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



x-axis

V_{ox} = constant

$V_{ox} = V_o \cos\theta$

$\Delta X = V_{ox} \cdot t$

$t = \frac{\Delta X_g}{V_{ox}} = \frac{\Delta X_g}{V_o \cos\theta} = \frac{25m}{13.4 m/s} = \boxed{1.87 s}$

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

- find where the ball is vertically

y-axis

$t = 1.87 s$

$V_{oy} = V_o \sin\theta$

$a_y = -g$

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

$y = V_o \sin\theta \, t - \frac{1}{2} g t^2$

$y = [20 \sin\theta (1.87 s)] - [\frac{1}{2}(9.8)(1.87^2)]$

$y = 10.7 m$

(b) Does the ball approach the crossbar while still rising or while falling?

The direction of the velocity will tell us.

$V_y = V_{oy} - g t$

$V_y = V_o \sin\theta - g t$

$V_y = 20 \sin\theta - 9.8(1.87)$

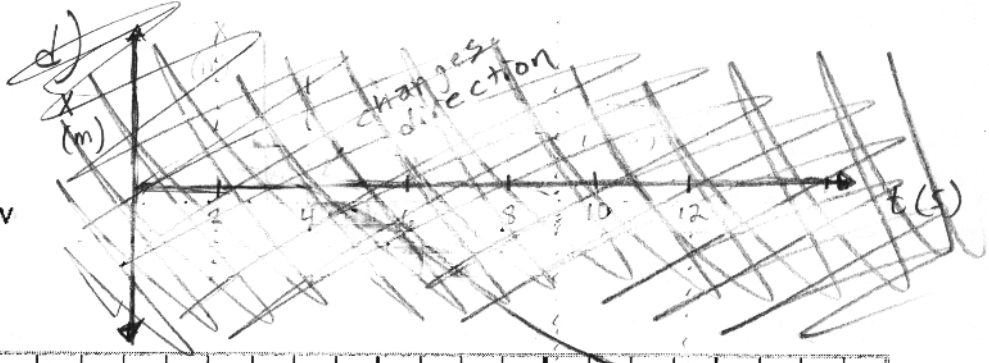
$V_y = -3.46 m/s$

falling

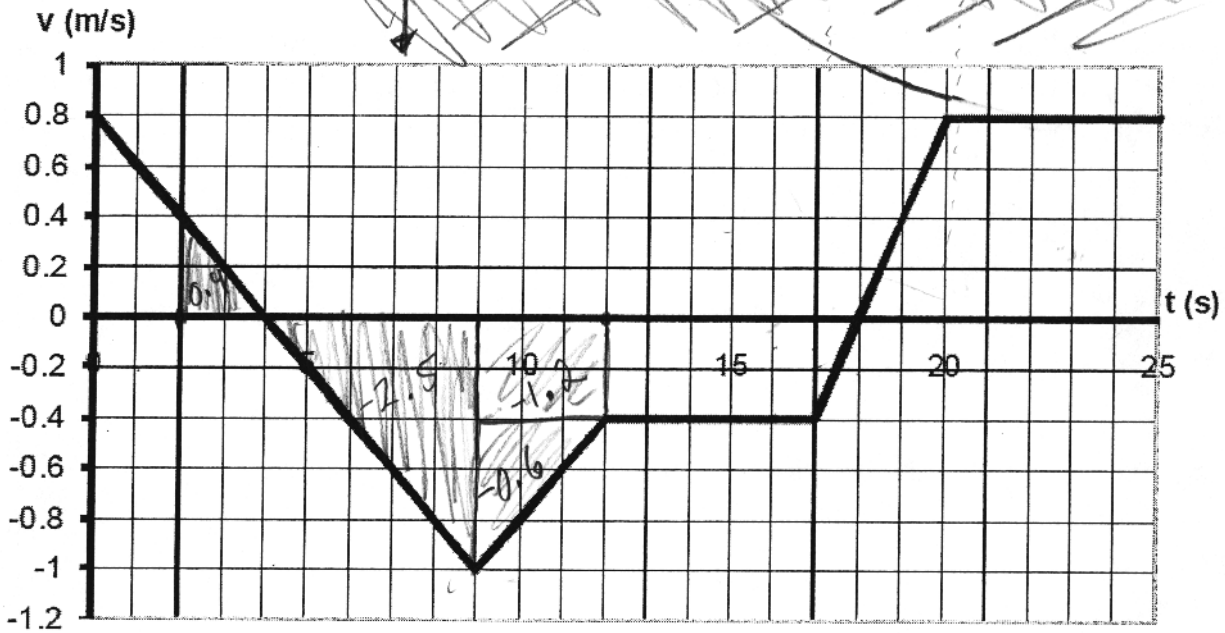
$10.7 m - 8 m = 2.7 m$ above

clears!

d)



2, . A particle mov
versus time



a. Indicate every time t for which the object's ~~speed~~ is decreasing. · When v is moving to zero

0-4s, 9-12s, 17-18s

b) Indicate every time t for which the object is moving in the positive direction.

· when V(+)

0-4s, 18-25s

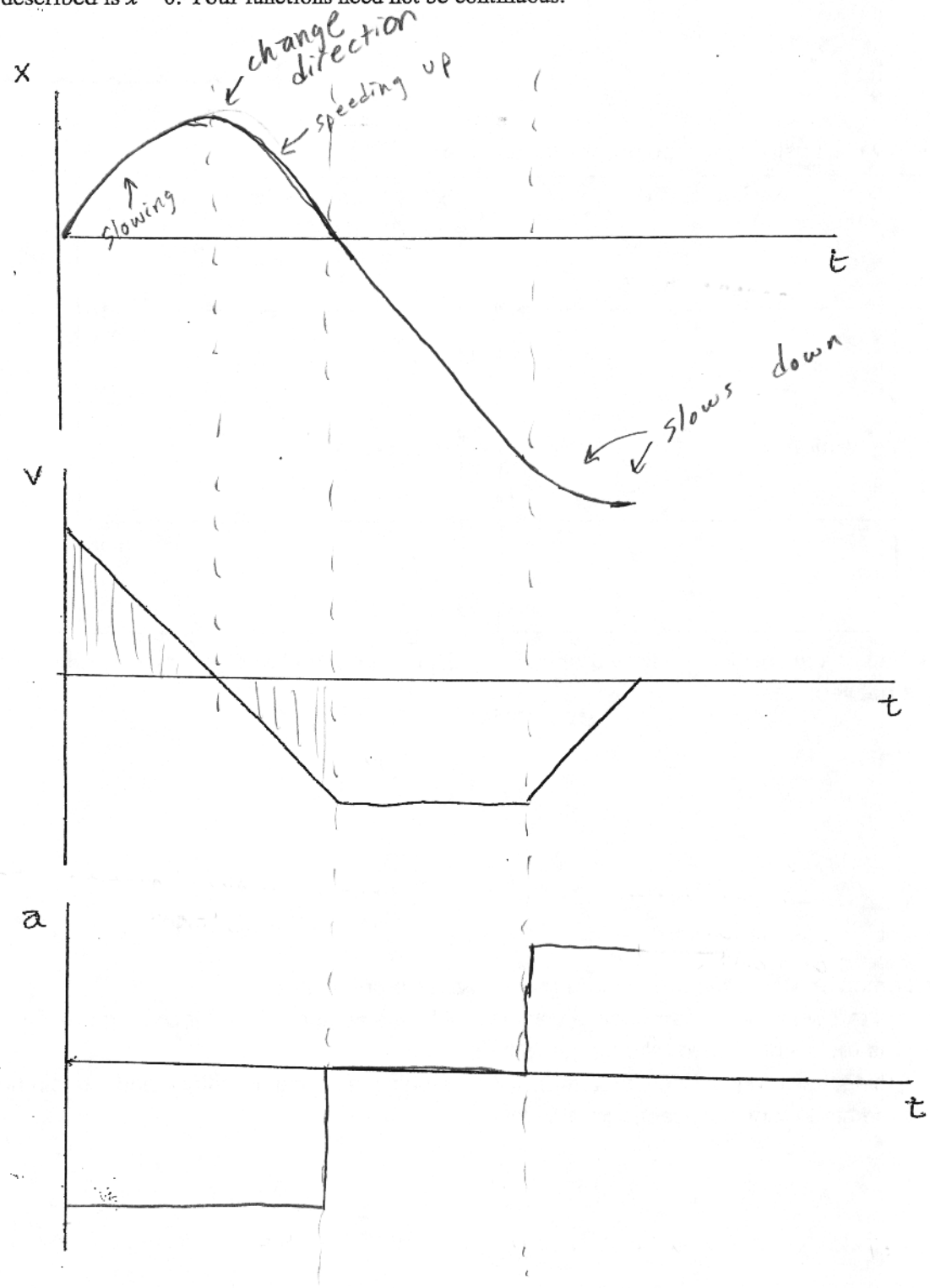
c) Determine the displacement of the object during the time interval from t = 2s to t = 12s.

Find the area under the curve.

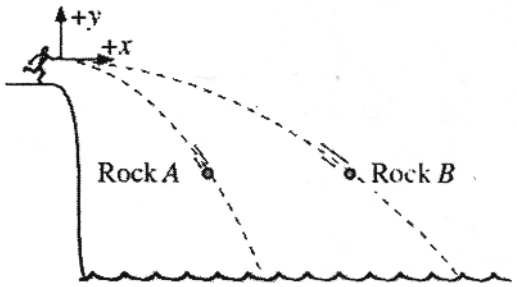
$\Delta X_{0-2s} = 0.4m$ $\Delta X_{2-12s} = -4.3m$ $\Delta X_{0-12s} = 0.4_m - 4.3_m = \boxed{-3.9_m}$

d) Sketch a position vs. time graph for the motion from t = Ø to t = 12s.

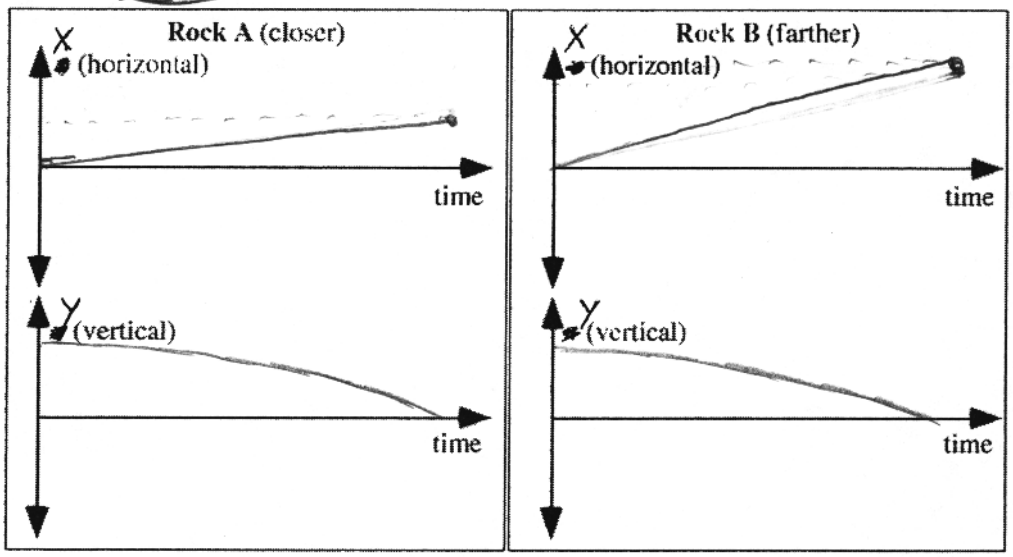
3. Sketch accurate schematic position *vs.* time and acceleration *vs.* time diagrams for the velocity *vs.* time diagram shown in the middle panel below. Assume that, at $t = 0$, the position of the object described is $x = 0$. Your functions need not be continuous.



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 position vs. time graphs for each rock.



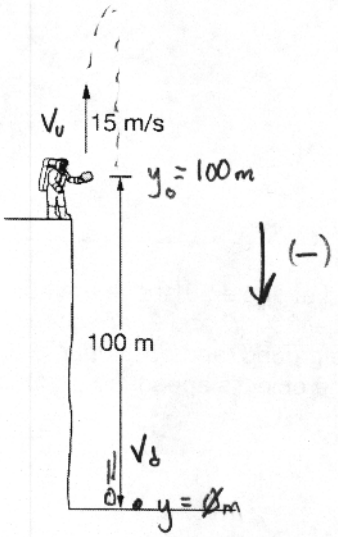
B. Compare the vertical position vs. time graphs for rocks A and B, and explain any similarities or differences between them.

- The vertical position graphs are identical because both objects start at the same height, accelerate at the same rate, and hit the ground at the same time.
- The horizontal position graphs should show motion at a constant rate, however B will have a steeper slope as its horizontal velocity is greater.

C. A student comes up with a different scenario and makes a prediction:
"If rock A was thrown with the same initial velocity but it was angled upward it could go as far horizontally as rock B but would take longer to hit the water."
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.

This statement is correct. If the rock is thrown at an upward angle it will have vertical velocity and horizontal velocity initially. This means the rock would rise vertically and then fall. This would result in more time spent in the air. Even with a smaller component of horizontal velocity, the additional time could allow the rock to displace farther.

KEY



1-D
Free Fall problem

5. An astronaut holds a rock 100m above the surface of Planet X. The rock is then thrown upward with a speed of 15m/s, as shown in the figure. The rock reaches the ground 10s after it is thrown. The atmosphere of Planet X has a negligible effect on the rock when it is in free fall.

(a) I am calling down a negative direction.

(i) Determine the acceleration due to gravity of the rock when it is on Planet X.

$V_o = 15 m/s$ $t = 10 s$

$\Delta y = -100 m$

$\Delta y = v_o t + \frac{1}{2} a t^2$

$\Delta y - v_o t = \frac{1}{2} a t^2$

$\frac{2(\Delta y - v_o t)}{t^2} = a$

$\frac{2((-100) - (15 \cdot 10))}{(10)^2} = \boxed{-5 m/s^2}$

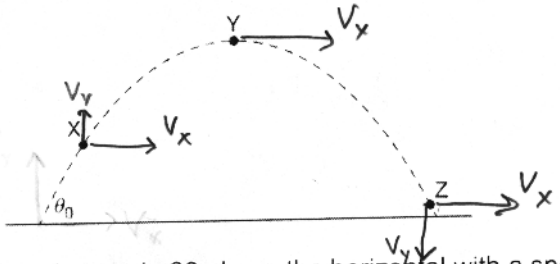
ii. How does the speed of the rock when it reaches the ground vd compare to the speed of the rock when it is thrown upward vu?

✓ vd>vu _____ vd=vu _____ vd<vu

Explain. The rock has a greater distance to accelerate downward than upward. When the rock returns to the thrower's hand it has $v = -15 m/s$, then it continues to accelerate in the negative direction.

(b) A student wants to know how the motion of the rock would be different if it was thrown upward at 15m/s from a height of 100m above Earth's surface. In a clear, coherent, paragraph-length response that may also contain figures and/or equations, explain how the motion of the rock on Earth will be different from its motion on Planet X in terms of its maximum height above the ground, the speed at which it reaches the ground, the time in which it is in free fall, and its acceleration due to gravity.

The rock experiences a greater value of acceleration on Earth of $a = -9.8 m/s^2$ or $-10 m/s^2$. This will result in a smaller maximum height due to the initial upward velocity reducing at a greater rate on the way upward. The speed the rock on Earth reaches the ground will be greater due to a greater acceleration for the same displacement. Finally, the time for the rock on Earth will be less due to the displacement being the same for both rocks so less time is required for greater acceleration.



6.

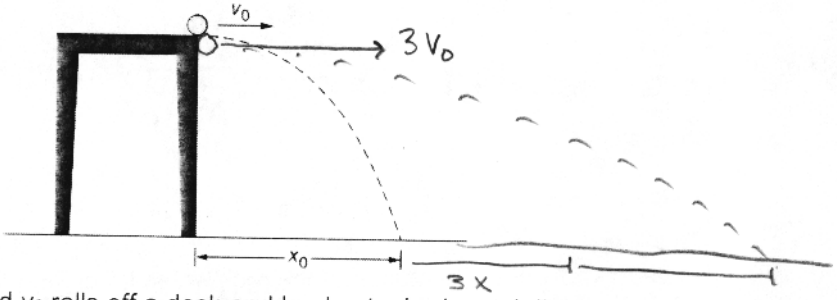
(9) An object is launched upward at angle θ0 above the horizontal with a speed of v_0. The trajectory and three positions of the object, X, Y, and Z, are shown in the figure. Position X is higher than position Z with respect to the ground, and position Y is at the object's maximum vertical position.

a. At what location is the object's speed the greatest? Explain

Z the vector sum of the velocity is the speed. $V=\sqrt{V_x^2+V_y^2}$

b. At what location is the object's acceleration the greatest? Explain

It is the same at all locations. (g, downward)



(7) A ball traveling at a speed v_0 rolls off a desk and lands at a horizontal distance x_0 away from the desk, as shown in the figure. The ball is then rolled off of the same desk at a speed of $3v_0$. At what horizontal distance will the ball land from the table?

Time in air is the same because Δy, V_{oy} and a_y are the same.

x-axis

$\Delta X = V_{0_x} t$

$\Delta X \propto V_{0_x}$

direct proportion

y-axis

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

$V_{oy} = 0$

$t = \sqrt{\frac{2\Delta y}{-g}}$ same for both!

$3V_0$ causes $(3\Delta X)$

$\boxed{3X_0}$