Phys 231 Exam 1
Feb. 9, 2018

NAME: Solutions

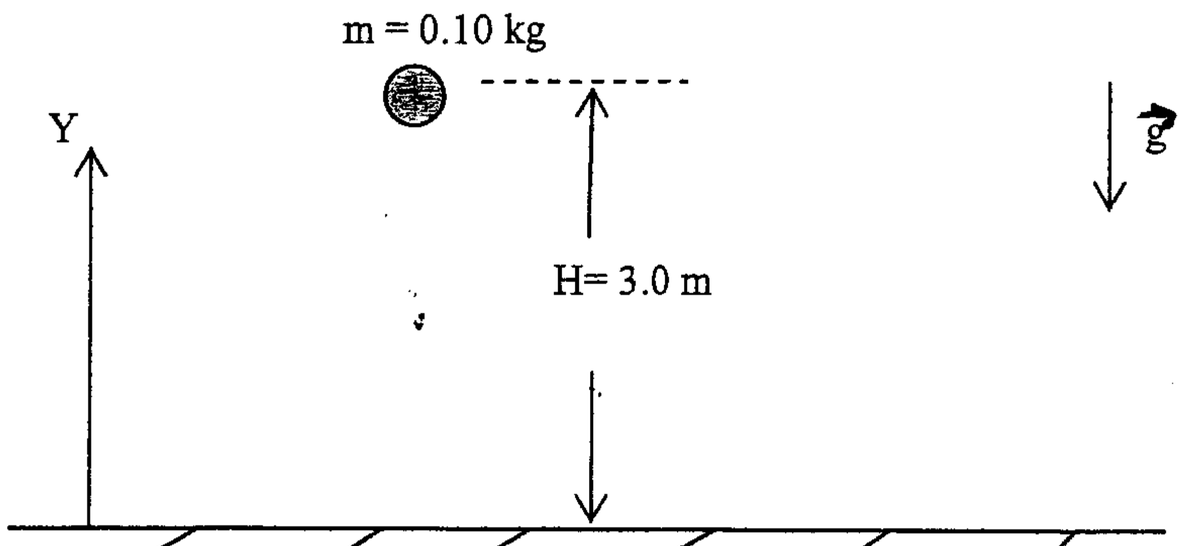
Student I.D. No_____.

Keep in mind that I must be able to follow your work in order to give you credit. This is especially true when awarding partial credit. A wrong answer with the right methods gets partial credit. If I cannot figure out the methods then no credit even if the answer is correct.

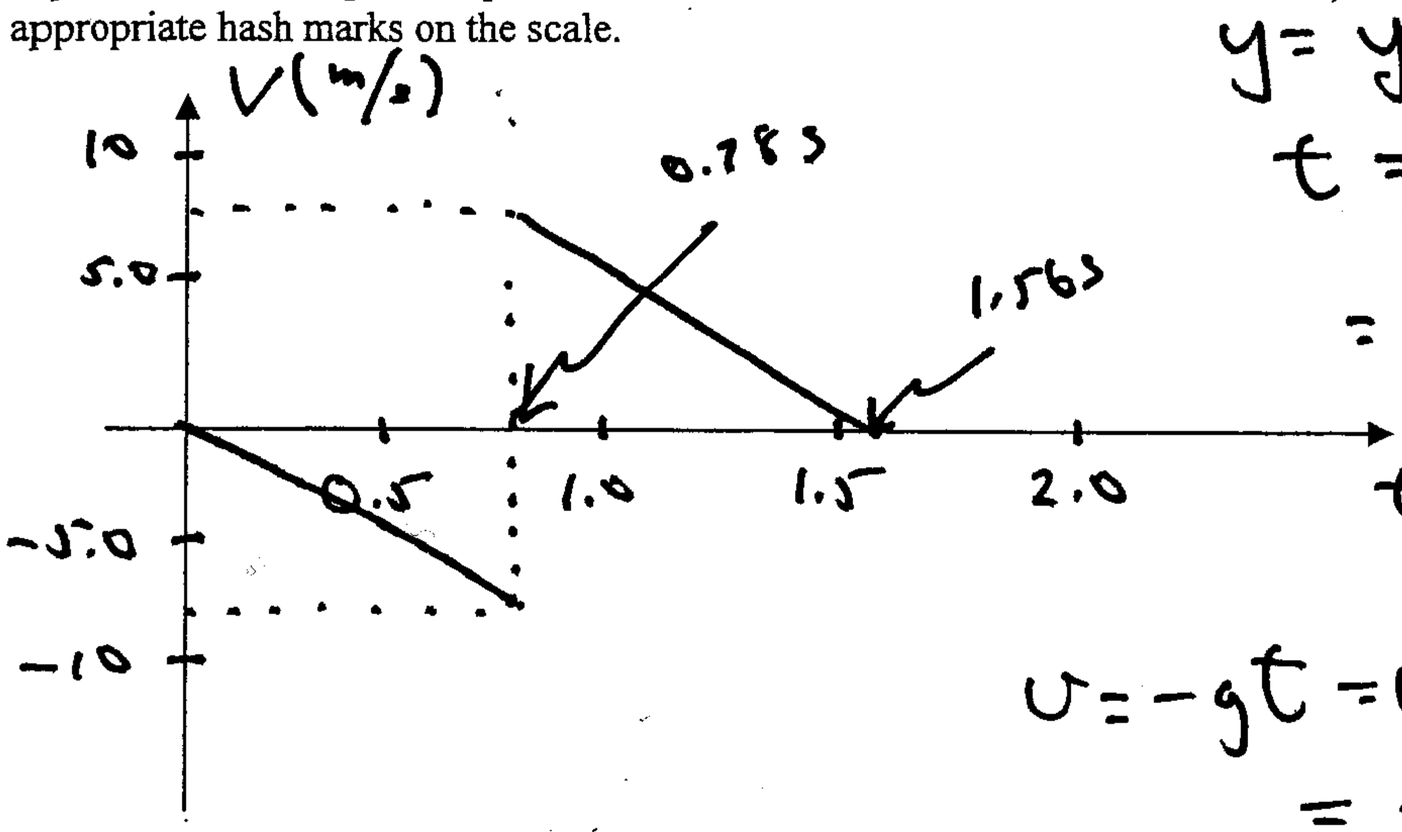
Answers must be justified. An answer by itself receives no credit.

All units, all the time!

1) (20 pts) A superball with a mass of 0.10 kg is released from rest at a height of 3.0 m above a rigid surface. Neglect friction and other complications. The ball hits the rigid surface and being a superball bounces back to its original height of 3.0 m.



a) In the space below, sketch a graph of velocity (vertical axis) versus time (horizontal axis) for the round trip of the superball. Choose up as the positive direction. Be certain to include axis labels, units, a numerical scale, and appropriate hash marks on the scale.



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

$$t = \sqrt{\frac{2y_0}{g}}$$

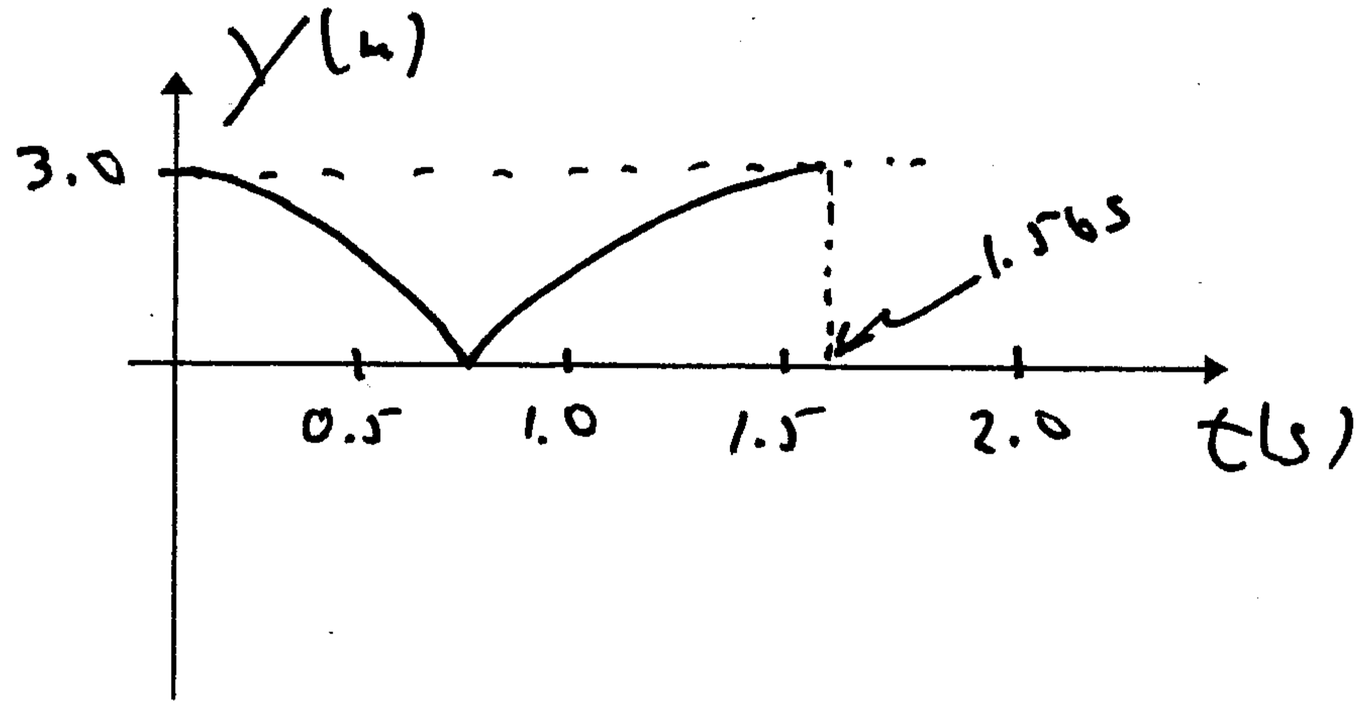
$$= \left[\frac{(2)(3.0\,m)}{9.8\,m/s^2}\right]^{1/2}$$

$$= 0.783$$

$$v = -gt = (-)(9.8\,m/s)(0.783)$$

$$= -7.64\,m/s$$

b) In the space below, sketch a quantitatively accurate graph of Y versus time for the superball. Be certain to provide a numerical scale, labels, units, hash marks, etc.



c) The ball hits the rigid surface and is heading upwards back towards its original position. At time of 0.50 s after hitting the surface, what is the acceleration of the ball? Acceleration is a vector.

$$\vec{a} = -9.8 \frac{m}{s^2} \hat{j}$$

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d) What is the <u>average</u> acceleration for the round trip? Acceleration is a vector.

$$a_{av} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t} = 0 \qquad \vec{v}_2 = \vec{v}_1 = 0$$

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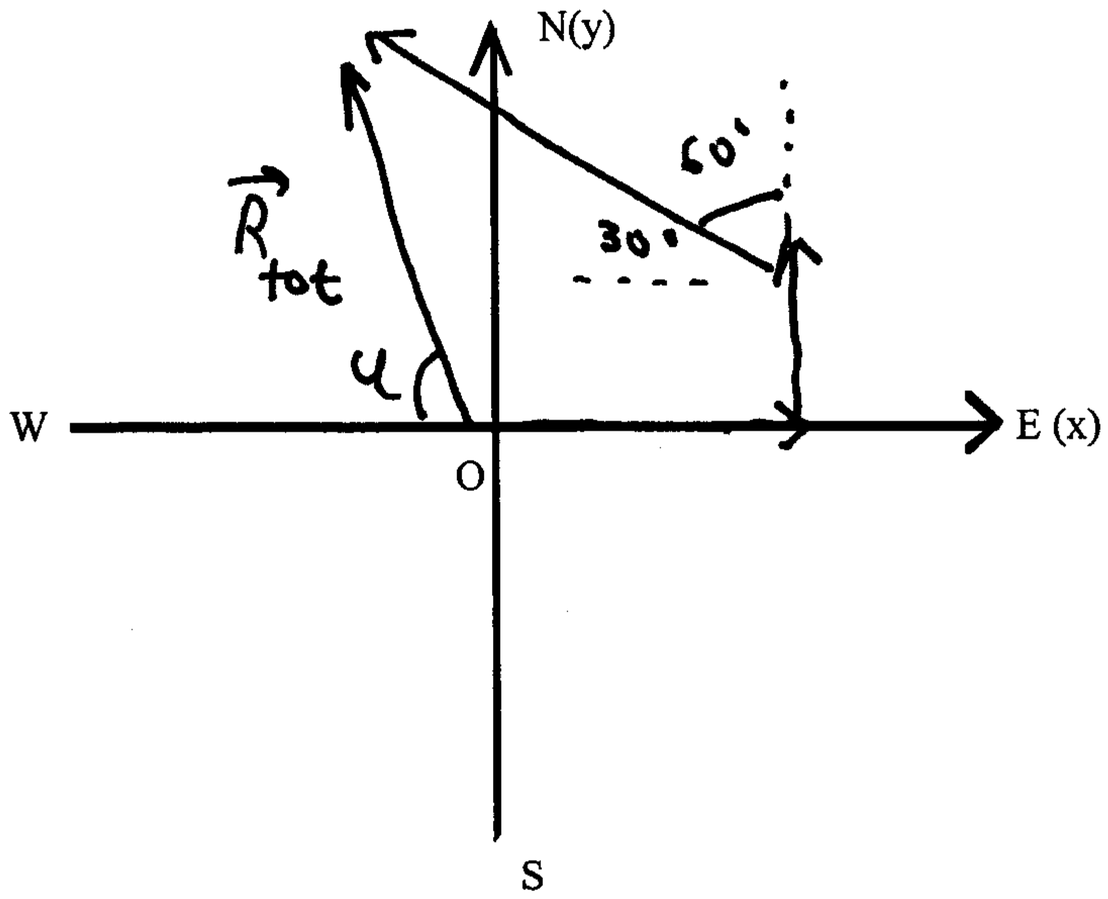
2) (15 pts) Starting at the origin labeled O, a hiker walks 5.0 km due east. This is followed by another displacement of 4.0 km due north. The hiker then walks 10 km in a northwesterly direction at angle of 60 degrees west of north (compass heading 300°).

a) In the space provided, draw four vectors approximately to scale. The first three vectors represent the three stages of the hiker's walk. The fourth vector (label it R_{tot}) should represent the vector sum of the first three vectors.



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b) How far is the hiker from the origin O?

$$R_{tot}^{(x)} = [5.0 - 10.0(\sin 60°)]\ km = -3.66\ km$$

$$R_{tot}^{(y)} = [4.0 + (10.0)(\cos 60°)]\ km = +9.00\ km$$

$$R_{tot} = [(-3.66)^2 + (9.00)^2]^{1/2} = 9.72\ km$$

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c) In what direction would a rescue team have to walk directly from the origin O in order to reach the hiker? You must calculate an angle. Be certain to specify the angle unambiguously. The best way to do this is with a diagram.

$$\tan\varphi = \frac{9.00}{3.66} = 2.46$$

$\varphi = 67.9^\circ$ N of W

see diagram

or 22.1° W of N

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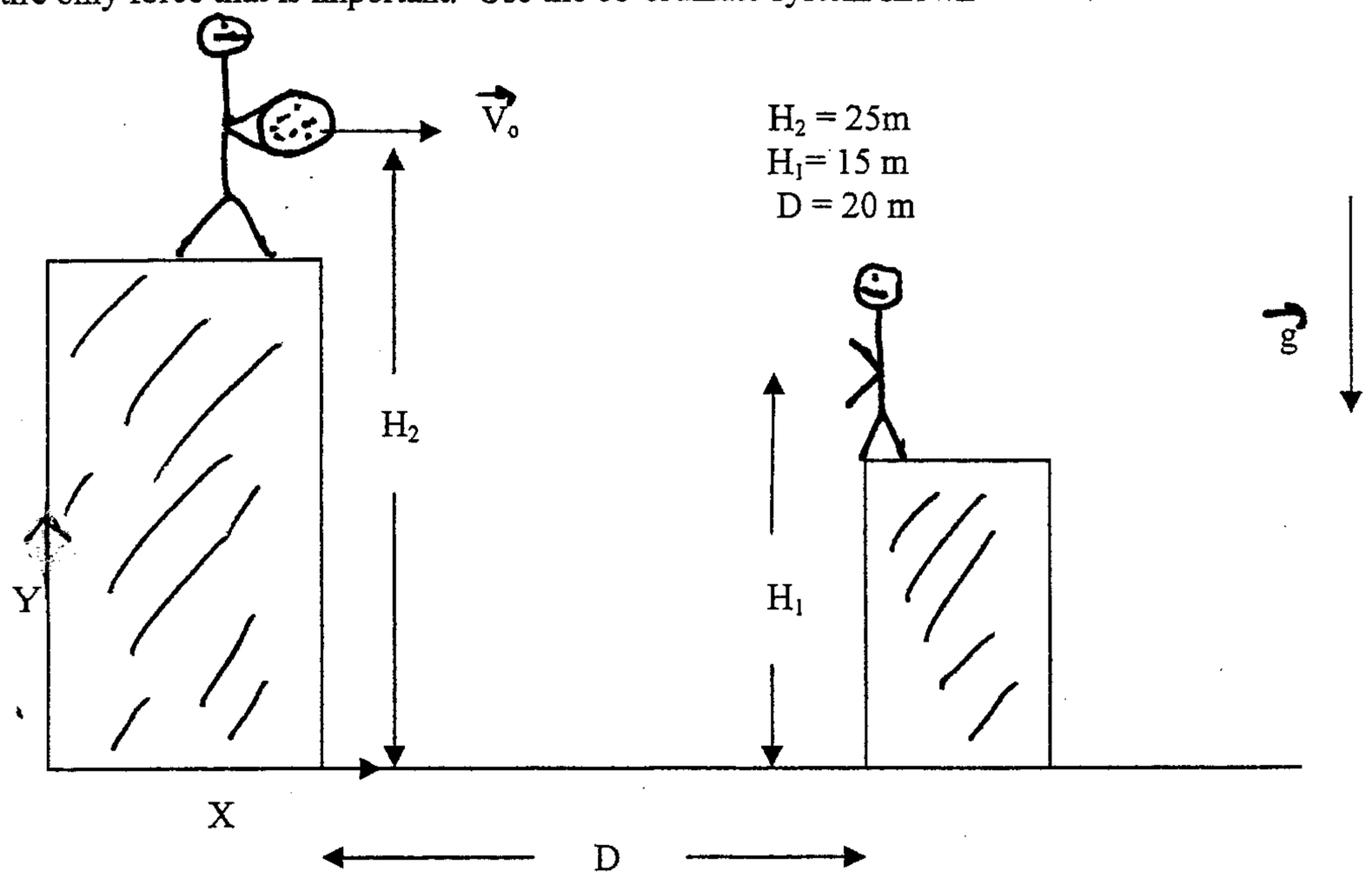
3) (15 pts) You throw a baseball horizontally to your friend on a building 20 m away. When the baseball leaves your hand, it is 25 m above the ground and your friend is 15 m above the ground. Assume that gravity is the only force that is important. Use the co-ordinate system shown



a) With what initial velocity must you throw the ball to make this work. Use the i,j component notation introduced in lecture.

$$\Delta y = -\frac{1}{2} g t^2 \qquad \Delta y = -10\ m$$

$$t = \left[\frac{(-2)(\Delta y)}{g}\right]^{1/2} = \left[\frac{(-2)(-10\ m)}{9.8\ m/s^2}\right]^{1/2} = 1.43s$$

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$$V_0 = \frac{D}{t} = \frac{20\ m}{1.43s} = 14.0\ m/s$$

$$\vec{V}_0 = 14.0 \frac{m}{s}\ \hat{i}$$

b) What is the velocity vector of the ball just before it is caught by your friend? Use the i,j component notation introduced in lecture.

$$V_x = 14.0\ m/s$$

$$V_y = V_0^{(y)} - gt = -gt$$

$$= -\left(9.8 \frac{m}{s^2}\right)(1.43s) = -14.0 \frac{m}{s}.$$

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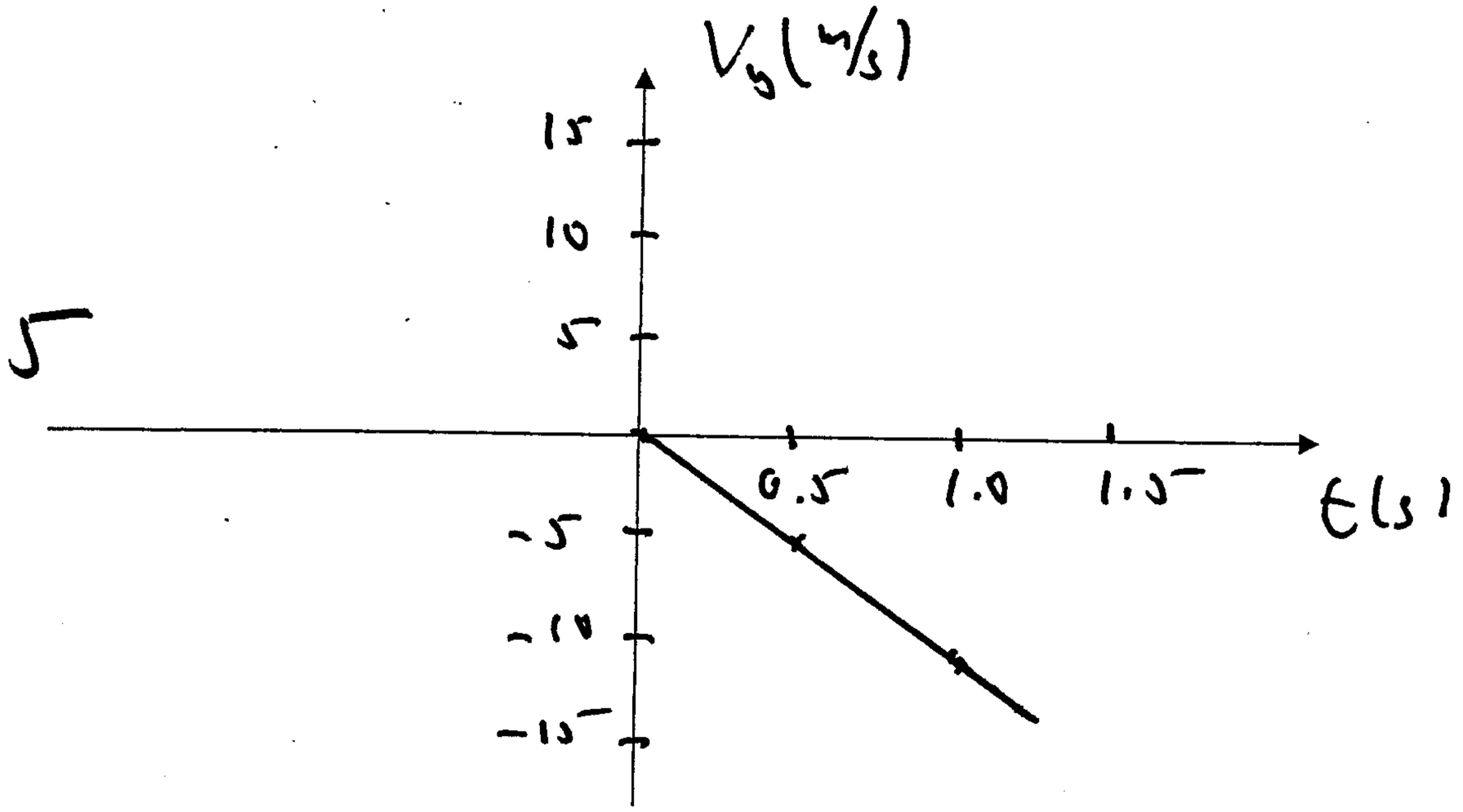
$$\vec{V} = (14.0\ \hat{i} - 14.0\ \hat{j})\ \frac{m}{s}$$

c) In the space below, sketch a graph of V_y, the y-component of velocity (vertical axis) versus time (horizontal axis). Be certain to include axis labels, units, numerical scales, and hash marks on your graph.



$$V_y(t) = -gt$$