PHYSICS 160 MIDTERM 1 VERSION A

Name SOLUTION

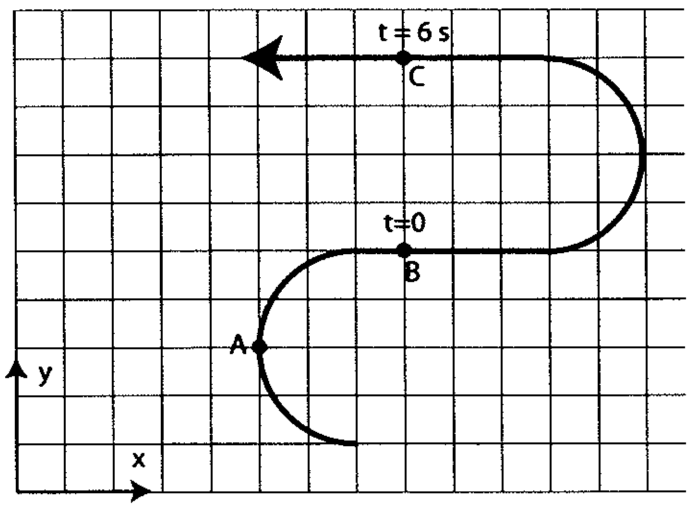
Multiple choice: 52%; Workout problems 48%

θ	sin(θ)	cos(θ)	tan(θ)
30° = π/6	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}$
45° = π/4	$\frac{1}{\sqrt{2}}$	$\frac{1}{\sqrt{2}}$	1
60° = π/3	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$

$\Delta x = v_0 t + \frac{1}{2}at^2$

1. If your test is "Version A", fill in circle [a]
   If your test is "Version B", fill in circle [b].

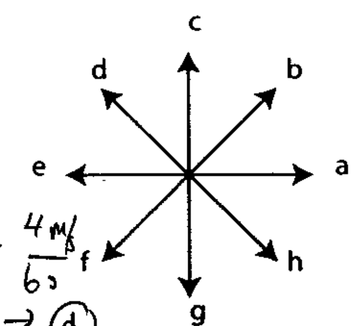
A model car moves at a uniform speed of 2 m/s on the path shown. Gridlines are 1 m apart. At t=0, the car is at point B; at t=6 seconds, the car is at point C.



2. What is the direction of the acceleration at point A?
Choose from the arrows, or
[i] some other direction, not shown
[j] a=0. a

3. What is the magnitude of the average velocity, in m/s, between points B and C? Choose from the answers at right. $\frac{\Delta x}{\Delta t} = \frac{4}{6}$ m/s d

4. What is the direction of the average velocity between points B and C?
Choose from the arrows, or
[i] some other direction, not shown
[j] v_{avg}=0 c $\vec{x}_f - \vec{x}_i$ = c↑B



5. What is the magnitude of the average acceleration, in m/s^2, between B and C?
Choose from the answers at right. $\frac{\Delta v}{\Delta t} = \frac{4\,m/s}{6\,s}$
$V_i = 2$ m/s → $V_f = 2$ m/s ← → d

6. What is the direction of the average acceleration between points B and C?
Choose from the arrows, or
[i] some other direction, not shown
[j] a_{avg}=0 ← e

For Questions 3,5,7,8
[a] 0
[b] 1/3
[c] 1/2
[d] 2/3
[e] 1
[f] 2
[g] 4
[h] 6
[i] 8
[j] not enough info given

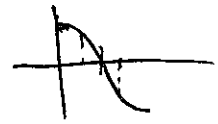
7. What is the magnitude of the acceleration at point B? a
8. What is the magnitude of the acceleration at point C? a

---

9. What is the angle between the vectors $\overset{A}{\hat{i}+\hat{j}}$ and $\overset{B}{-\hat{i}-\hat{k}}$?
Use the back of the page for your calculation, if you need to.

$A \cdot B = -1 = \sqrt{2}\sqrt{2}\cos\theta$

$\cos\theta = -\frac{1}{2}$



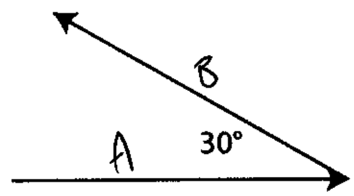
$\theta = 90^\circ + 30^\circ$

[a] 0°
[b] 30°
[c] 45°
[d] 60°
[e] 90°
[f] 120°
[g] 135°
[h] 150°
[i] 180°

10. What is the magnitude of the cross product of the two vectors shown?
Each vector has magnitude = 2.

[a] 0
[b] 1
[c] $\sqrt{3}$
[d] 2
[e] $2\sqrt{3}$
[f] 4
[g] 8

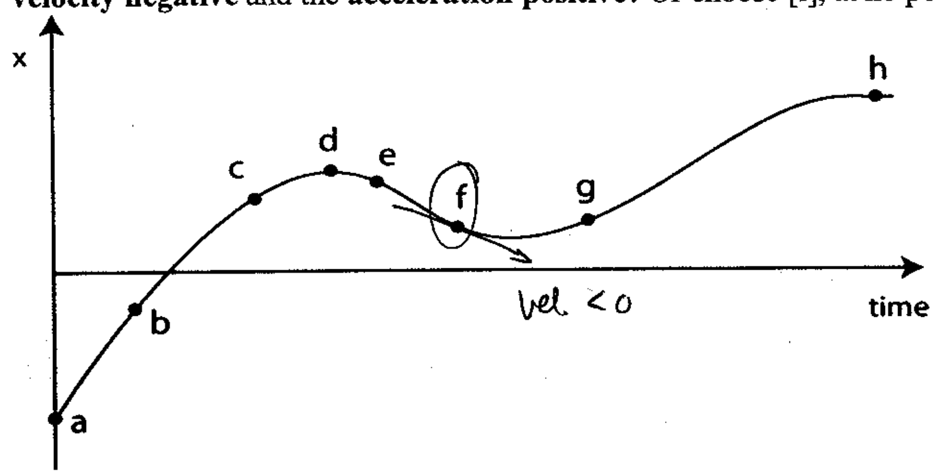
$2 \cdot 2 \cdot \sin 150^\circ$
$= 2 \cdot 2 \cdot \sin 30^\circ$
$= 2.$



11. What is the direction of the cross product of the two vectors above? $\vec{A}\times\vec{B}$

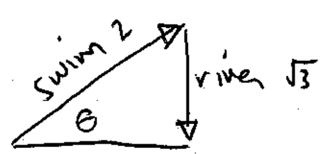
[a] out of the page
[b] into the page
[c] down
[d] up
[e] left
[f] right
[g] another direction that can't be found without a calculator
[h] magnitude = 0 so no direction.

12. The graph shows position x vs time, for a 1-dimensional motion. At what point is the **velocity negative** and the **acceleration positive**? Or choose [i], at no point shown.



13. You wish to swim straight across (eastward) a river flowing at $\sqrt{3}$ m/s south. You can swim at 2 m/s in still water. What direction should you swim?

[a] Due east
[b] $\theta = \arctan(\sqrt{3}/2)$ north of east
[c] $\theta = \arccos(\sqrt{3}/2)$ north of east
[d] $\theta = \arcsin(\sqrt{3}/2)$ north of east
[e] $\theta = \arctan(\sqrt{3}/2)$ south of east
[f] $\theta = \arccos(\sqrt{3}/2)$ south of east
[g] $\theta = \arcsin(\sqrt{3}/2)$ south of east
[h] some other direction
[i] it can't be done unless you swim faster



For the remaining problems, write out your solutions neatly. You may use the backs of pages.
On problem I, you may certainly do parts b before parts a, if you don't like the graphical approach.
I. One hot air balloon is rising with constant speed v, another descends with constant speed v. As they pass, the rising balloon 'drops' a sandbag.

1. Sketch the velocities of the balloons and the sandbag as a function of time on graph paper below.

2a. On your sketch, indicate the time(s), if any, when the sandbag is at the same height from the ground as when it was 'dropped'.

2b. What time after dropping is this? Express your answer in terms of v, g.

$$\Delta y = 0 = \underbrace{V_{oy}}_{=V} t - \frac{1}{2} g t^2 \qquad t = \frac{2V}{g}$$

3a. On your sketch, indicate the time(s), if any, when the sandbag is descending at the same speed as the second balloon.

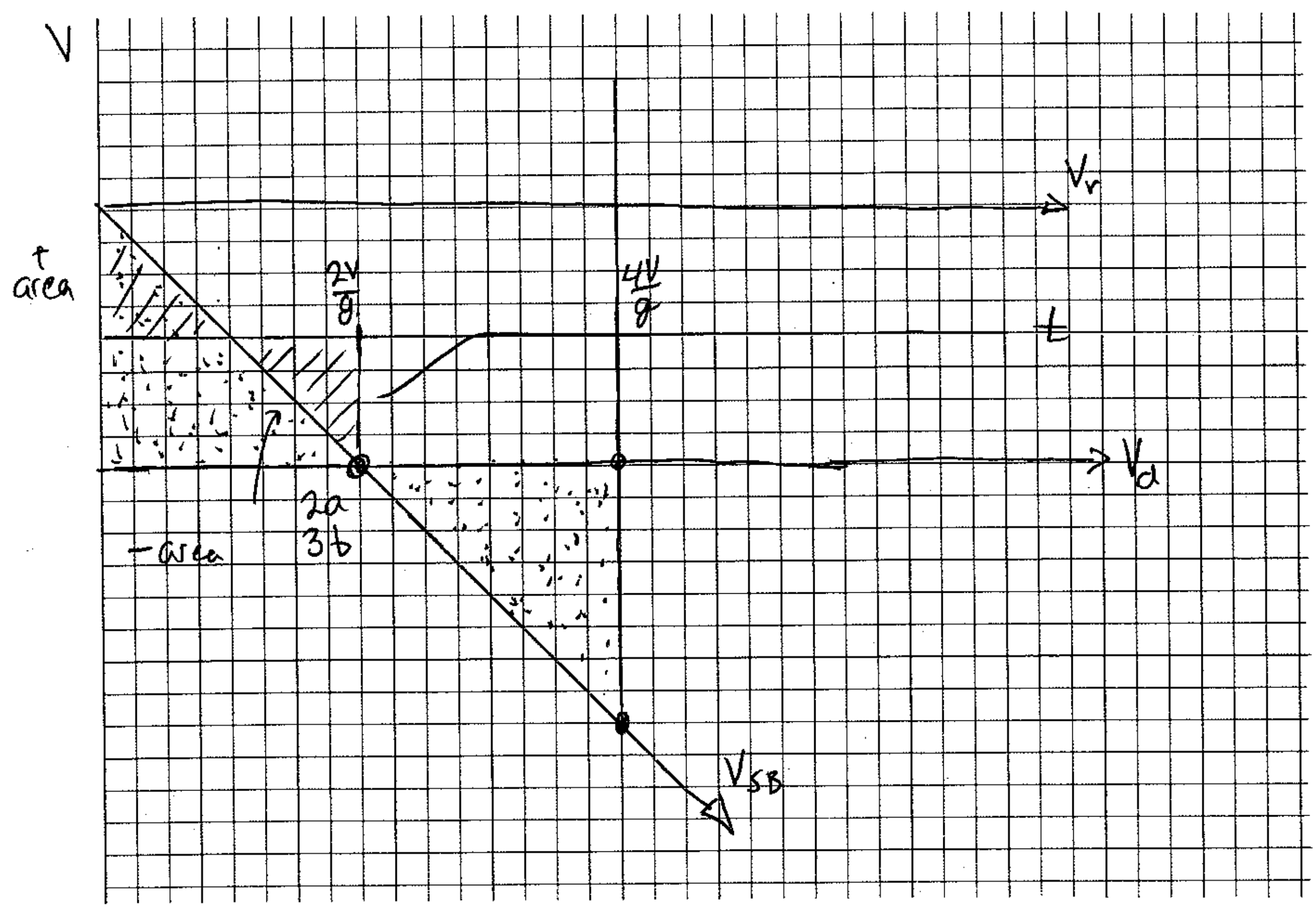
3b. What time after dropping is this? Express your answer in terms of v, g.

$$t = \frac{2V}{g}$$

4a. On your sketch, indicate the time(s), if any, when the sandbag is at the same height as the descending balloon. (Assume neither hits the ground.) *Show or explain your work on the back of this page. You may do part b first if you like.*
b. What time after dropping is this? Express your answer in terms of v, g.

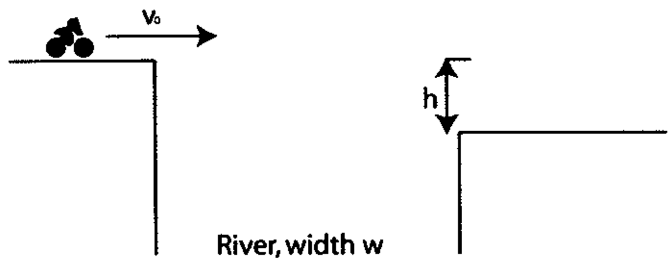
Either solve by areas, or $x_d = x_{sb}$

$$-vt = +vt - \frac{1}{2} g t^2 \qquad t = \frac{4v}{g}.$$



II. A motorcylist wishes to jump a river of width w. The banks of the river are level, as shown; the bank she will jump from is a height h above the bank she will land on.

1. Mathematically express the condition that the jump is successful.



$\Delta x > w$

when $\Delta y = -h$

2. What are the equations of motion that describe the x and y coordinates of the motorcyclist after she leaves the ground?

$x = V_0 t$

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

3. What is the minimum speed v_0 she must have for a successful jump? Express your answer in terms of w, h, g. You may use the back of this sheet for calculations.

$-\frac{1}{2} g t^2 = -h \quad \Rightarrow \quad t = \sqrt{\frac{2h}{g}}$

$x = V_0 \sqrt{\frac{2h}{g}} > w$

$$\boxed{V_0 > w \sqrt{\frac{g}{2h}}}$$

4. Use scantron sheet, question #14:

The motorcyclist finds a spot on the river that is twice as wide as before (w'=2w), but with a drop h' that is twice as high (h' = 2h.) (Takeoff is level, as before.)
To succeed at this new jump, her minimum initial speed must be:

[a] only half of the previous v_0
[b] $1/\sqrt{2}$ times the previous v_0
[c] the same as the previous v_0
[d] $\sqrt{2}$ times the previous v_0
[e] twice the previous v_0
[f] four times the previous v_0
[g] eight times the previous v_0
[h] not enough information given

$V_0' = 2w \sqrt{\frac{g}{4h'}} = \sqrt{2}\, w \cdot \sqrt{\frac{g}{2h}}$

--END OF PHYSICS 160 MIDTERM 1--