Physics 220
Spring Semester 2008
Anthony Pantziris

EXAM 1

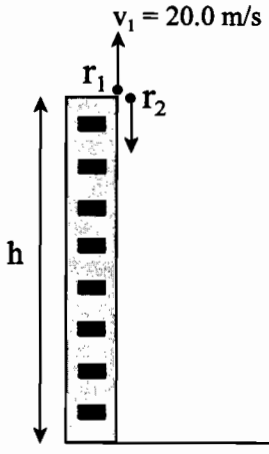
1

Name: _____ unid: u _ _ _ _ _ _ _ _

Discussion TA (circle): Aaron Yuan Xiao

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

A rock is thrown upwards from the edge of the top of a building with an initial velocity of $v_1 = +20.0$ m/s.



8′ (a) If the rock (r_1) reaches the ground in 6.00 s after it was thrown, what is the height (h) of the building?

6′ (b) Calculate the speed with which the rock hits the ground.

6′ (c) A second rock (r_2) is thrown downwards from the top of the same building 3.00 s after the first rock. Both rocks hit the ground at the same time. What was the initial velocity (v_2) of the second rock?

a). $X_f = X_i + V_i t - \frac{1}{2} g t^2$

$\Rightarrow X_f - X_i = V_i t - \frac{1}{2} g t^2$

$= 20 \times 6 - \frac{1}{2} \times 9.8 \times 6^2$ 6′ = 4+1+1 (substitution)

$= -56.4$ m 2′

the height of the building is 56.4 m.

b) $|V_f| = |V_i - gt|$ 5′ = 3+2

$= |20 - 9.6 \times 6| = 38.8$ m/s 1′

the speed is 38.8 m/s

c) $-56.4 = V_2 \cdot 3 - \frac{1}{2} \times 9.8 \times 3^2$ 5′ = 4+1′ (substitution)

$\Rightarrow V_2 = -4.10$ m/s 1′

so the initial velocity of the 2nd rock is 4.1 m/s downwards.

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The position of a car along the x axis is given by the expression

$$x = \left(-t^2 + 4.00\,t + 20.00\right)\text{m}$$

where t is in seconds.

(a) Write an expression for the car's velocity as a function of time.
(b) At what time does the car stop?
(c) What is the instantaneous velocity at t = 3.00 s?
(d) What is the acceleration of the car?
(e) What is the average velocity between t = 0 and t = 5.00 s?

a) $\vec{v}(t) = \frac{d\vec{x}}{dt} = (-2.00t + 4.00)\ m$

b) stops when $v = 0$

so $0 = -2.00t + 4.00$

$\Rightarrow t = 2.00\ s$

c) $\vec{v}(3.00s) = -2.00(3.00) + 4.00$

$= -2.00\ m/s$

d) $\vec{a}(t) = \frac{d\vec{v}}{dt} = \frac{d^2\vec{x}}{dt} = -2.00\ m/s^2$

or just see $\frac{1}{2}at^2 = -1.00t^2$

$\Rightarrow a = -2.00\ m/s^2$

e) $\frac{\Delta\vec{x}}{\Delta t} = \frac{x(5) - x(0)}{5.00 - 0.00} = \frac{15.0 - 20.0}{5.00} = -1.00\ m/s$

or $\frac{1}{2}(v_i + v_f) = \frac{1}{2}(4.00 + -6.00) = -1.00\ m/s$

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3

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REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

Given the following vectors

$$\vec{A} = 2.00\hat{i} - 4.00\hat{j} + 1.00\hat{k}$$
$$\vec{B} = -1.00\hat{i} + 4.00\hat{j} + 2.00\hat{k}$$
$$\vec{C} = 3.00\hat{i} - 1.00\hat{k}$$

-1' significant digits error 2 times or more

(a) Calculate the x, y and z components of $\vec{A} - \vec{B} + \vec{C}$.

(b) Write $\vec{A} - \vec{B}$ in $\hat{i}$, $\hat{j}$, $\hat{k}$ notation.

(c) Find the magnitude of $\vec{A} + 2.00\vec{B}$,

(d) Find the direction of $\vec{A} + \vec{C}$ as an angle measured counterclockwise from the x axis.

(e) Find the magnitude of $\vec{A} - \vec{B} + \vec{C}$

4' a) $\vec{A} - \vec{B} + \vec{C} = (2+1+3)\hat{i} + (-4-4)\hat{j} + (1-2-1)\hat{k} = 6.00\hat{i} - 8.00\hat{j} - 2.00\hat{k}$

The x, y, z components are 6.00, -8.00 and -2.00.

4' b) $\vec{A} - \vec{B} = (2.00+1.00)\hat{i} + (-4.00-4.00)\hat{j} + (1.00-2.00)\hat{k} = +3.00\hat{i} - 8.00\hat{j} - 1.00\hat{k}$

4' c) $\vec{A} + 2.00\vec{B} = (2\vec{i} - 4\vec{j} + 1\vec{k}) + (-2\vec{i} + 8\vec{j} + 4\vec{k})$

$= (2-2)\hat{i} + (-4+8)\vec{j} + (1+4)\vec{k} = 4.00\vec{j} + 5.00\vec{k}$

$|\vec{A} + 2.00\vec{B}| = \sqrt{4^2+5^2} = 6.40$

4' d) $\vec{A} + \vec{C} = (2.00+3.00)\vec{i} - 4.00\vec{j} + (1.00-1.00)\vec{k}$

$= 5.00\vec{i} - 4.00\vec{j}$

$\Rightarrow \theta = 2\pi - \arctan\frac{4}{5} = 5.61$ or 321° or -38.7°

4' e) $\vec{A} - \vec{B} + \vec{C} = (2.00+1.00+3.00)\vec{i} + (-4.00-4.00\vec{j}) + (1.00-2.00+1.00)\vec{k}$

$= 6.00\vec{i} - 8.00\vec{j} - 2.00\vec{k}$

$|\vec{A} - \vec{B} + \vec{C}| = \sqrt{6^2+8^2+2^2} = 10.2$