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Physics 112: Midterm – November 2017 #1

Name - Key Date - Tuesd. Nov. 21

Solve the following problems on your own paper. Show full solutions.

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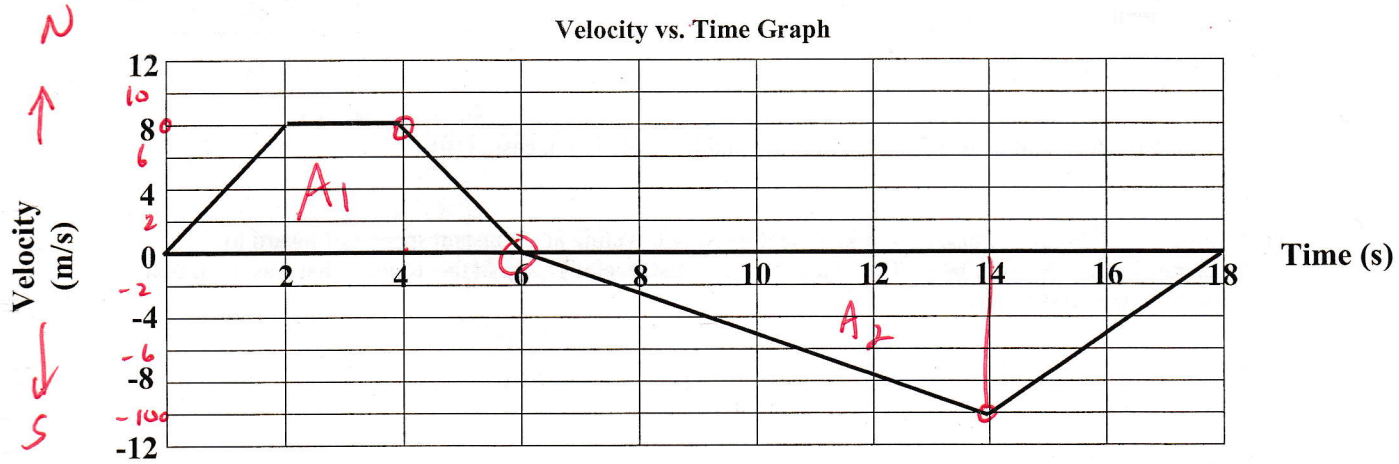
1. Use the velocity-time graph to answer the questions below. Assume that the positive direction is north. Use north and south to describe the directions of vector quantities in your final answers. Show work when calculations are required on loose leaf. Express all answers to two significant digits.
   a) What was the maximum speed of the object? (1) 10m/s.
   b) What was the average acceleration of the object between t = 4 s and t = 14 s? (3) $1.8\ m/s^2$, S.
   c) What was the average velocity of the object between t = 0 s and t = 14 s? (5) 0.57 m/s, S
   d) At what time, if any, did the object change direction? (1) t = 6.0 s
   e) In what direction was the object traveling at t = 5.0 s? (1) north



b) (4, 8), (14, −10)

$$\vec{a} = \frac{-10-8}{14-4} = \frac{-18}{10} = -1.8\ m/s^2$$

$$m = \frac{\Delta y}{\Delta x}$$

$$A = \frac{1}{2}bh \qquad A = \frac{1}{2}(a+b)h$$

c) $A_1 = \frac{1}{2}(2+6)8$

$A_1 = 32\ m.$

$$A_2 = \frac{1}{2}(8)(10) = 40\ m.$$

$$\vec{v}_{av} = \frac{32-40}{14} = -0.57\ m/s$$

$$\frac{-8}{14}$$

$$\text{distance} = A_1 + A_2 + A_3 + \ldots$$

$$\text{displacement} = \pm A_1 \pm A_2 \pm A_3 \pm \ldots$$

$$\text{average speed} = \frac{\text{distance}}{\text{time}}$$

$$\text{average velocity} = \frac{\text{displacement}}{\text{time}}$$

2. A musician applies a horizontal westward force of 17 N to an instrument case. The case slides across a table with a westward acceleration of 0.39 m/s^2. If the coefficient of kinetic friction between the case and the table is 0.32, what is the mass of the instrument case? Include a labeled FBD for the instrument case. (12)

3. A rock is thrown vertically downward with a speed of 1.4 m/s from the top of a cliff. How long does it take the rock to hit the water 45.9 m below? (8)

4. A student on planet Luvfizics presses a 2.1 kg textbook against a vertical wall. The student applies a force of 59 N in order to prevent the textbook from sliding down the wall. What is the acceleration due to gravity on LuvFizics? Include a labelled FBD for the textbook. (10)

Note:

Surfaces	μ_s	μ_k
textbook and wall	0.284	0.196

5. Calculate the resultant of **A** = 71.9 km/h, south and **B** = 95.2 km/h, east. (10)

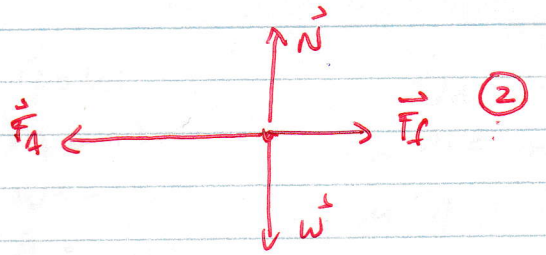
6. A force of 125 N south causes a 345 kg object initially traveling at a constant speed northward to accelerate uniformly for 20.4 s. The object travels a distance of 182 m in this time. What was the initial velocity of the object? (8)

2. $F_A = 17\,N$

$a = 0.39\,m/s^2$

$\mu = 0.32$

$m = ?$



(2)

2nd Law

$\vec{F}_{net} = m\vec{a}$ (1)

$+F_f - F_A = m(-a)$ (3)

$\mu N - F_A = -ma$ (1)

$\mu W - F_A = -ma$ (1)

$\mu mg - F_A = -ma$ (1)

$\mu mg + ma = F_A$ (1)

$m = \dfrac{F_A}{\mu g + a}$ (1)

$m = \dfrac{17}{(0.32)(9.80) + 0.39}$

$m = 4.8\,kg$ (1)

Then mass is 4.8 kg.

[12]

3. $\vec{v}_i = -1.4\,m/s$ (1)

$t = ?$

$\vec{d} = -45.9\,m$ (1)

$\vec{a} = -9.80\,m/s^2$ (1)

Freely falling body

$\vec{v}_f^{\,2} = \vec{v}_i^{\,2} + 2\vec{a}\vec{d}$ (1)

$\vec{v}_f = \sqrt{(-1.4)^2 + 2(-9.80)(-45.9)}$

$\vec{v}_f = -30.0\,m/s$ (1)

$\vec{v}_f = \vec{v}_i + \vec{a}t$ (1)

$t = \dfrac{\vec{v}_f - \vec{v}_i}{\vec{a}}$ (1)

$t = \dfrac{-30.0 - (-1.4)}{-9.80}$

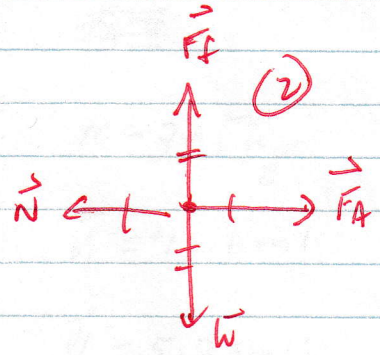
$t = 2.9\,s$ (1)

$-45.9 = -1.4t - 4.90t^2$

It took 2.9 s to hit the water.

[8]

4.



(2)

1st Law

$F_f = W$
$F_A = N$
$W = mg$
$F_f = \mu N$

$\mu_s = 0.284$ (1)

$\vec{g} = ?$

$F_A = 59$ N
$m = 2.1$ kg

$F_f = W$ (1)
$\mu N = mg$ (2)
$\mu F_A = mg$ (1)

$g = \frac{\mu F_A}{m}$ (1)

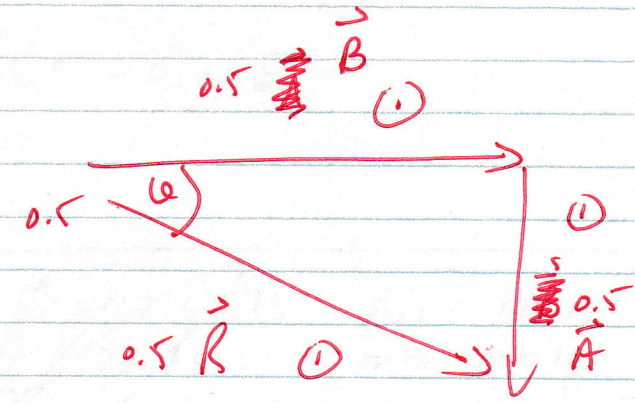
$g = \frac{(0.284)(59)}{2.1}$ 10

$g = 8.0 \text{ m/s}^2$ (1)

The acc. due to gravity is 8.0 m/s^2, down (1).

5. $\vec{A} = 71.9$ km/h, S.
$\vec{B} = 95.2$ km/h, E

$R = \sqrt{(71.9)^2 + (95.2)^2}$
$R = 119$ km/h. (2)



$\tan\theta = \frac{71.9}{95.2}$ (2)

$\theta = 52.9^\circ$
37.1°

10

$\vec{R} = 119$ km/h, 37.1° Sq. E (1).

52.9° E of S.

6. ~~F_A =~~

2nd Law

$m = 345\ kg$

net force = ? $\vec{F}_{net}$

$\vec{v}_i = +12.6\ m/s$

$\vec{v}_f = +5.23\ m/s$

$\vec{d} = +182\ m$

$\vec{v}_f^{\,2} = \vec{v}_i^{\,2} + 2\vec{a}\vec{d}$

$\frac{\vec{v}_f^{\,2} - \vec{v}_i^{\,2}}{2\vec{d}} = \vec{a}$

$\vec{d} = \frac{1}{2}(\vec{v}_i + \vec{v}_f)t$

$\vec{a} = \frac{(5.23)^2 - (12.6)^2}{2(182)}$

$\frac{2\vec{d}}{\vec{v}_i + \vec{v}_f} = t$

$\vec{a} = -0.3610\ m/s^2$

$\frac{2(182)}{12.6 + 5.23} = t$

$\vec{F}_{net} = m\vec{a}$

$t = 20.4\ s$

$(345)(-0.3610)$

~~$F_{net} =$~~ $125\ N$

$\vec{v}_i = 12.6\ m/s$

$t = 20.4\ s$

$\vec{d} = 182\ m$

$\vec{F}_{net} = m\vec{a}$

$F_{net} = 125\ N$

$m = 345\ kg$

$\vec{a} = \frac{\vec{F}_{net}}{m}$

$\vec{a} = \frac{125}{345}$

$a = 0.3623\ m/s^2$

$\vec{d} = \vec{v}_i t + \frac{1}{2}\vec{a}t^2$

$\frac{\vec{d} - \frac{1}{2}\vec{a}t^2}{t} = \vec{v}_i$

$\frac{182 - \frac{1}{2}(0.3623)(20.4)^2}{20.4}$

$\vec{v}_i = 12.6$

#2 - 12
#3 - 8
#4 - 10
#5 - 10
#6 - 8

$\vec{F}_{net} = -125\ N$ (1)

$m = 345\ kg$

$\vec{F}_{net} = m\vec{a}$ (1)

$\vec{a} = \frac{\vec{F}_{net}}{m}$ (1)

$\vec{a} = \frac{-125}{345}$

$\vec{a} = -0.3623\ m/s^2$ (1)

8

$t = 20.4\ s.$

$\vec{d} = 182\ m$

$\vec{v_i} = ?$

$\vec{d} = \vec{v_i} t + \frac{1}{2}\vec{a}t^2$ (1)

$\frac{\vec{d} - \frac{1}{2}\vec{a}t^2}{t} = \vec{v_i}$ (1)

$\frac{182 - \frac{1}{2}(-0.3623)(20.4)^2}{20.4} = \vec{v_i}$

$\vec{v_i} = 12.6\ m/s$ (1)

(1)

$\rightsquigarrow$ 12.6 m/s, North.