Monday October 6 2014 Uni Lee

# Grade 12 University Physics Celebration #1

| K/U | C | A | T/I |
|---|---|---|---|
| [redacted] /14 | He didnt even mark anyone's comm section /5 | [redacted] /18 | [redacted] /11 |

## Part A: KNOWLEDGE

Answer all multiple choice questions in the space provided below:

4

1. ~~B~~ 2. ~~B~~
3. C ✓ 4. C ✓
5. E ✓ 6. E ✓

Fill in the blanks
(one mark per blank)

7. A 5.0 kg mass and a 3.0 kg mass on attached to the opposite ends of an ideal rope. The rope goes over a frictionless pulley, which is attached to a ceiling, and the masses are allowed to hang vertically (the 5.0 kg mass is on the left side of the pulley, while the 3.0 kg mass is on the right side of the pulley).

3

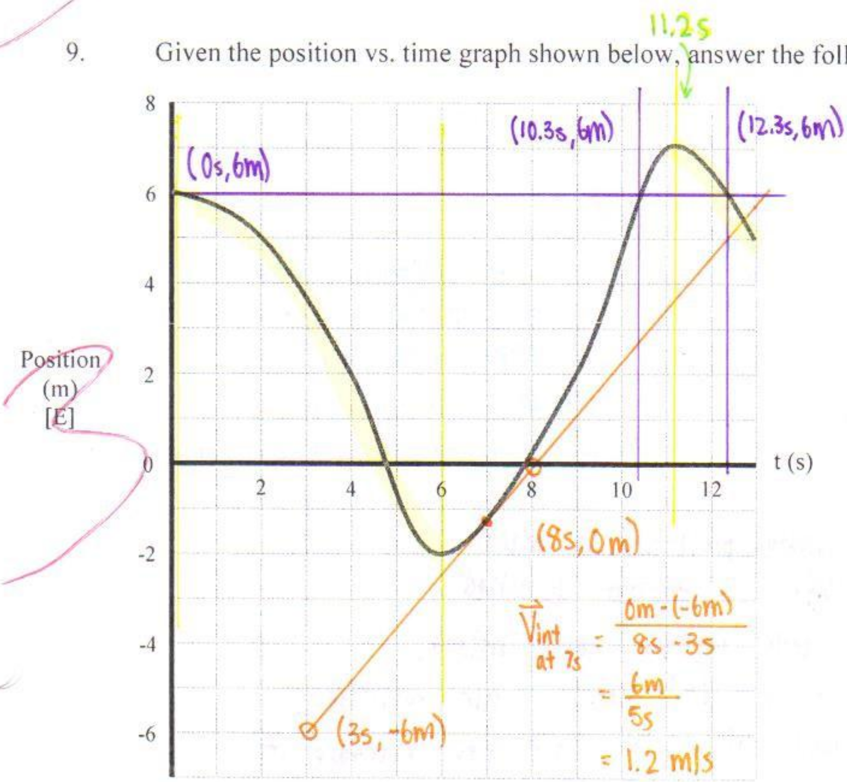
a) What is the acceleration of the masses? $2.5 \times 10^0$ m/s$^2$ [down on left] ✓

b) What is the tension in the rope? $3.7 \times 10^1$ N ✓

8. A 17.5 kg mass is on a frictionless ramp that is inclined at an angle of 38°. What is the magnitude of the mass' acceleration?

$6.0 \times 10^0$ m/s$^2$ ✓

9. Given the position vs. time graph shown below, answer the following questions:




3

a) What is the instantaneous velocity at 7.0 s?

$\vec{V}_{int@7.0s} = 1.2 \times 10^0$ m/s [E] ✓

b) At what time(s) does the object return to its starting position?

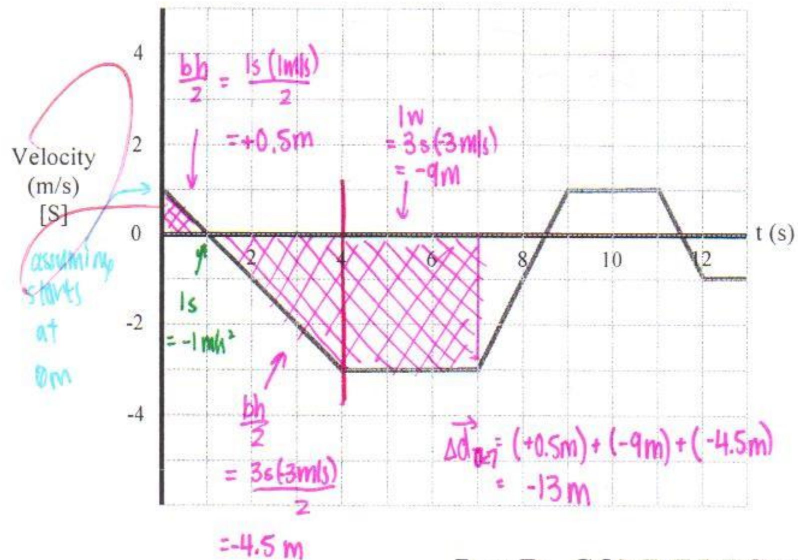
10.3 s and 12.3 s ✓

c) During which intervals is the object travelling west?

during 0s-6s and after 11.2s ✓

10

10. Given the velocity vs. time graph shown below, answer the following questions:




a) What was the displacement from 0.0 s to 7.0 s?

$\vec{\Delta d}_{0s-7.0s} = 1.3 \times 10^1 m$ [N]

b) What is the acceleration of the object at 1.0 s?

$\vec{a}_{1.0s} = 1.0 \ m/s^2$ [N]

## Part B: COMMUNICATION

1. A bird is sitting on a scale that measures in newtons. The scale shows a reading of 5.7 N. The bird gets steps off the scale and begins to fly, from a location that is about 1 m beside the scale (at this point the scale shows a reading of 0 N). The bird turns and flies horizontally, in a straight line, about 1 m above the ground. The bird flies over the scale. What will be the reading on the scale as the bird flies over it? Justify your answer.


**The right answer was the scale says equal or less than 5.7N because:**

**"The wind from the bird's wings pushes the scale"**

**-.-**

$F = mg$

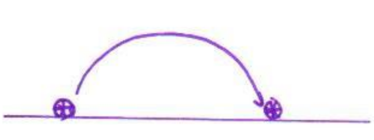
$5.7 = m(9.81)$

$m = 0.58$ kg

- as the bird flies over the scale, it will read 0 N. the scale reads how much force the bird is doing on the scale. When it flies over, it doesn't touch the scale.


← air from flapping keeping bird up. Not the scale keeping bird up. so scale would read 0 N

2. What is a simple projectile? A ball is thrown from the surface of the Earth. Is the ball a simple projectile? Explain your answer.



- a simple projectile is when the object is ~~thrown~~ launched and lands on the same height. And when it ignores air resistance
- The ball will land back on surface of the earth. So yes, its a simple projectile

# Part C: APPLICATION

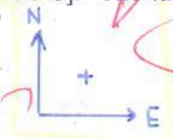
(provide full solutions for each question)

1. After an airplane has finished a turn, it has a velocity of 237 km/h [N63°W]. During the turn, its average acceleration was 3.25 m/s$^2$ [W38°S]. The turn took 0.35 minutes to complete. What was the velocity of the plane, prior to the turn?

[8]

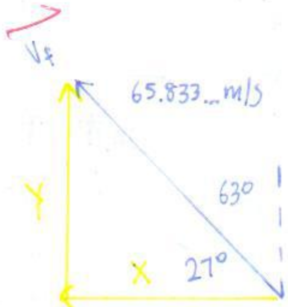
$\vec{v}_f = 237\ \frac{km}{h} \times \frac{1000m}{1km} \times \frac{1h}{3600s} = 65.833...\ m/s$ dir?

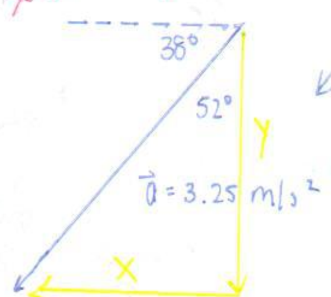
$\Delta t = 0.35\ min \times \frac{60s}{1min} = 21s$

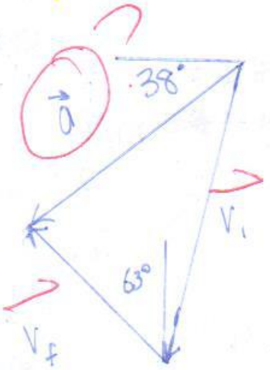



where are x and y?

$\Delta v = a(\Delta t) = 3.25\ (21s) = 68.25\ m/s$ dir?





$\vec{V}_{avgy} = \vec{V}_{fy} + \vec{V}_{iy}$ $\quad$ $\vec{V}_{avgx} = \vec{V}_{fx} + \vec{V}_{iy}$

$\vec{V}_{ix} = \vec{V}_{avgy} - \vec{V}_{fy}$ $\quad$ $V_{iy} = V_{avgx} - V_{fx}$

$= -42.0188\ m/s - (-29.889)$ $\quad$ $= -53.78\ m/s - (58.657)\ m/s$

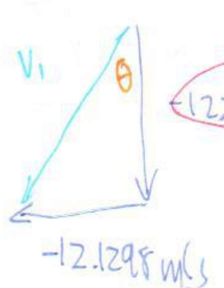
$= -12.1298\ m/s$ $\quad$ $= -112.437\ m/s$

where did these come from?

$\tan\theta = \frac{-12.1298}{-122.437}$

$\theta \doteq 5.6°$

what is this?

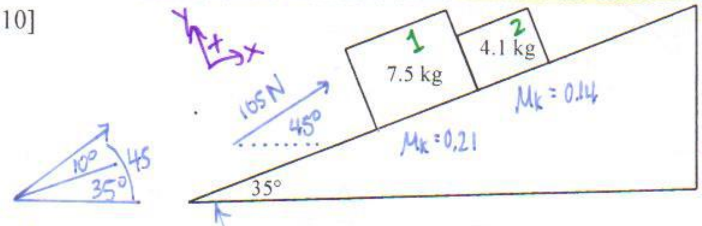


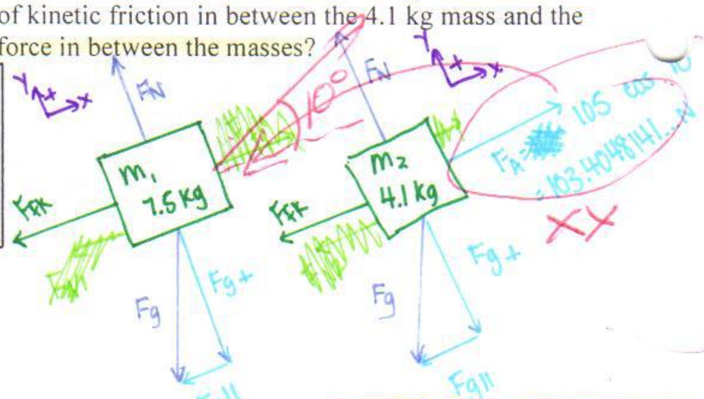

∴ the initial $\vec{v}_1$

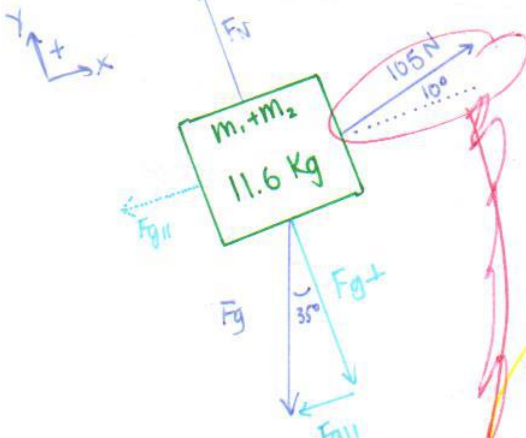
$1.2 \times 10^2$ m/s [S 5.6° W]

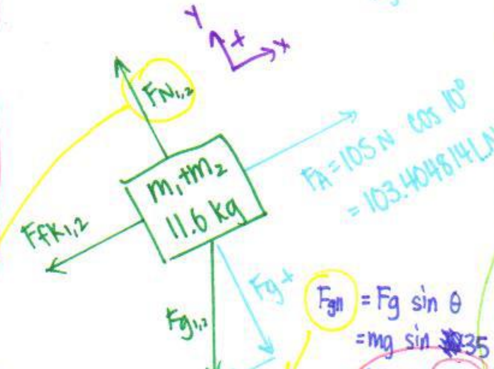
2. Two masses are on an incline (see the accompanying diagram). A force of 105 N [right 45° up] is applied to the 7.5 kg mass. The coefficient of kinetic friction in between the 7.5 kg mass and the surface of the incline is 0.21, while the coefficient of kinetic friction in between the 4.1 kg mass and the surface of the incline is 0.14. What is the reaction force in between the masses?

[10]




$m_1 \vec{a} = \sum \vec{F}_{1y}$

$0 = F_{N_1} + (-F_{g_1\perp})$

$F_{N_1} = mg \cos\theta$

$= 7.5\text{ kg}(9.81\text{ m/s}^2)\cos 35°$

$= 60.26911166\ldots\text{ N}$

$m_2 \vec{a} = \sum \vec{F}_{2y}$

$0 = F_{N_2} + (-F_{g_2\perp})$

$F_{N_2} = mg \cos\theta$

$= 4.1\text{ kg}(9.81\text{ m/s}^2)\cos 35°$

$= 32.947114\ldots\text{ N}$

$F_{g\parallel} = F_g \sin\theta$

$= mg \sin 35$

$= 65.2707\ldots\text{ N}$

$\vec{F}_{fk_{TL}} = \vec{F}_{fk_1} + \vec{F}_{fk_2}$

$= -(\mu_{k_1})(F_{N_1}) + (-)(\mu_{k_2})(F_{N_2})$

$= -(0.21)(60.26911166\text{ N}) + (-0.14)(32.947114\ldots\text{ N})$

$= -17.269105\ldots\text{ N}$

$m\vec{a} = \sum \vec{F}_y$

$0 = F_N + (-F_{g\perp})$

$F_{N_{1,2}} = mg \cos 35°$

not really true

$= 11.6\text{ kg}(9.81\text{ m/s}^2)\cos 35°$

$= 93.216226\ldots\text{ N}$

$m_{1+2}\vec{a}_x = \sum \vec{F}_{1+2\,x}$

$11.6\text{ kg}\,\vec{a} = (+103.4048141\ldots\text{ N}) + (-18.257274\ldots\text{ N}) + (-17.269105\text{ N})$

$\vec{a} = \dfrac{67.8785\ldots\text{ N}}{11.6\text{ kg}}$

$= 5.85159\ldots\text{ m/s}^2$ [up the incline]

| going down | going up |
|---|---|
| $F_{g\parallel} = F_g \sin 35°$ | $F_A = 105\text{ N}(\cos 10°)$ |
| $= mg \sin 35°$ | $\boxed{= 103.4048141\ldots\text{ N}}$ |
| $= 11.6\text{ kg}(9.81\text{ m/s}^2)\sin 35°$ | |
| $\boxed{= 65.2707\ldots\text{ N}}$ $\boxed{<}$ | |

∴ system accelerates up the ramp (friction acts down)

6

$m_1\vec{a} = \sum \vec{F}_{1x}$

$(7.5\text{ kg})\,5.85159\ldots\text{ m/s}^2 = (+103.4048141\ldots\text{ N}) + (-F_{2/1}) + (F_{fk_1}) + (-F_{g_1\parallel})$

$= (+103.4048141\ldots\text{ N}) + (-F_{2/1}) + (-0.21)(60.269111\text{ N}) + (-7.5\ldots)$

(sin 30)

What type of force exists in between the masses? compression

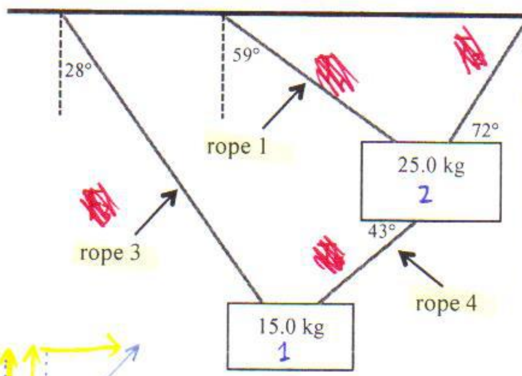
$(F_{2/1}) + 7.5\text{ kg}(5.85159\text{ m/s}^2) = 53.96081\text{ N}$ ?

$F_{2/1} = 10.07\text{ N}$

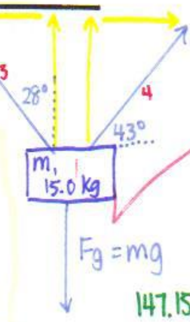
Therefore, the force between the masses is $1.0 \times 10^1$ N

# Part D: TIPS

Two masses are connected to a ceiling by a series of ropes (see the accompanying diagram). Find the tension in each of the following ropes (note the ropes are labeled).
[11 marks]








$\cancel{m_1 a_y}^{\emptyset} = \Sigma \vec{F}_{1y}$

$\emptyset = (-F_g) + (F_{3y}) + (F_{4y})$

$mg = F_{3y} + F_{4y}$

$15\text{ kg}(9.81\text{ m/s}^2) = (F_3)(\cos 28°) + (F_4)(\cos 47°)$

$147.15\text{ N} = F_3(\cos 28°) + F_4(\cos 47°)$

$147.15\text{ N} - F_3(0.8829) = F_4(0.68199)$

① $F_4 = \dfrac{147.15\text{ N} - F_3(0.8829)}{0.68199}$ ... on all

$\cancel{m_1 a_x}^{\emptyset} = \Sigma \vec{F}_{1x}$

$\emptyset = (F_{3x}) + (F_{4x})$

$= F_3(\sin 28°) + F_4(\sin 47°)$

$-F_3(0.46947) = F_4(0.73135)$

② $F_4 = \dfrac{-F_3(0.46947)}{0.73135}$

sub ① into ②

$\dfrac{147.15\text{ N} - F_3(0.8829)}{0.68199} = \dfrac{-F_3(0.46947)}{0.73135}$

$0.68199[-F_3(0.46947)] = [147.15\text{ N} - F_3(0.8829)] \times 0.73135$

$-0.68199(F_3)(0.46947) = -0.73135(F_3)(0.8829) + 107.618...\text{ N}$

$-0.3201738845(F_3) = -0.6457089(F_3) + 107.618...\text{ N}$

$-107.618 = -0.32553507(F_3)$ follows

$F_3 = 330.265026...\text{ N}$

③ $\boxed{F_3 \doteq 3.3 \times 10^2\text{ N}}$

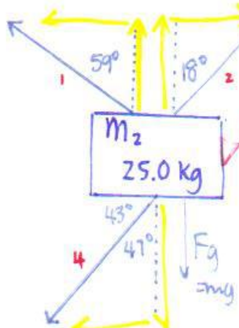
sub ③ into ①

$F_4 = \dfrac{147.15\text{ N} - (330.265026...\text{ N})(0.8829)}{0.68199}$

$= 211.7934078...\text{ N}$

answer is negative (which is a problem)

④ $\boxed{F_4 \doteq 2.1 \times 10^2\text{ N}}$




$\cancel{m_2 a_y}^{\emptyset} = \Sigma \vec{F}_{2y}$

$\emptyset = (-F_{4y}) + (F_{1y}) + (F_{2y}) - F_{2g}$

sub in ④ $\rightarrow = (-F_4)(\cos 47°) + F_1(\cos 59°) + F_2(\cos 18°) + (-F_g)$

$-F_2(\cos 18°) = (-211.7934078...\text{ N})(\cos 47°) + F_1(\cos 59°) + (15\text{ kg})(9.81)$ 25

⑤ $-F_2 = \dfrac{-144.44275...\text{ N} + F_1(\cos 59°) - 147.15\text{ N}}{0.9510565}$ 25

$\cancel{m_2 a_x}^{\emptyset} = \Sigma \vec{F}_{2x}$

$\emptyset = (-F_{4x}) + (-F_{1x}) + (F_{2x})$

sub ④ in $\rightarrow = (-F_4)(\sin 47°) + (F_1)(\sin 59°) + (F_2)(\sin 18°)$

$-F_2 = \dfrac{(-211.7934078...\text{ N})(\sin 47°) + (-F_1)(\sin 59°)}{\sin 18°}$

⑥ $-F_2 = \dfrac{-154.8958871\text{ N} - F_1(0.857167)}{0.30901699}$

sub ⑤ into ⑥

$\dfrac{-144.44275...\text{ N} + F_1(\cos 59°) - 147.15\text{ N}}{0.9510565} = \dfrac{-154.8958871\text{ N} - F_1(0.857167)}{0.30901699}$

$0.9510565[-154.895887\text{ N} - F_1(0.857167)] = 0.30901699[-291.59275\text{ N} + F_1(0.51503)]$

$-147.3147335\text{ N} - F_1(0.815214) = -90.107...\text{ N} + F_1(0.51503)(0.30901699)$

$-57.207733...\text{ N} = 0.97435651(F_1)$

$F_1 = 58.713348...\text{ N}$ ← this is negative which is a problem

⑦ $\boxed{F_1 \doteq 5.9 \times 10^1\text{ N}}$

sub ⑦ into ⑥

$-F_2 = \dfrac{-154.8958871\text{ N} - (58.713348\text{ N})(0.857167)}{0.30901699}$

$= -664.085...\text{ N}$

$\boxed{F_2 = 6.6 \times 10^2\text{ N}}$

Therefore, the tension in rope 1 is $5.9 \times 10^1$ N, in rope 2 is $6.6 \times 10^2$ N, in rope 3 is $3.3 \times 10^2$ N, and in rope 4 is $2.1 \times 10^2$ N