PHY151H1F FALL 2022 Test 2

Prakash Shivesh

TOTAL POINTS

15 / 20

QUESTION 1

1 Q1 4 / 4

✓ **+ 2 pts Correct answer with correct logic.**

+ 1.5 pts Minor logic mistakes.

+ 1 pts Some correct logic.

✓ **+ 2 pts Coherent and complete answer.**

+ 1.5 pts Mildly confusing, or partially incomplete.

+ 1 pts Confusing but complete, or mildly confusing and partially incomplete.

+ 0.5 pts Confusing and partially incomplete.

+ 0 pts No marks for this answer.

QUESTION 2

2 Q2 4 / 4

✓ **- 0 pts Correct**

QUESTION 3

3 Q3 7 / 12

Making And Communicating Assumptions

+ 4 pts Reasonable assumptions, clearly communicated

+ 3 pts Minor unreasonable/questionable assumption

+ 3 pts Reasonable assumptions/clear communication, but some assumptions were not used/needed

+ 2 pts Major unreasonable/questionable assumption

✓ **+ 2 pts Did not communicate an assumption that was used**

+ 1 pts Made at least one useful assumption

+ 0 pts No reasonable assumptions were communicated

Solving the Physics Problem

+ 4 pts Problem solved to get an answer

+ 3 pts Minor mistake when solving problem

✓ **+ 2 pts Major mistake when solving problem**

+ 2 pts Reasonable attempt with well-done sketch of the situation

+ 1 pts Reasonable attempt made at solving the problem

+ 0 pts No reasonable attempt to solve the problem

Evaluating your answer

+ 4 pts Answer was compared to a simple solution

✓ **+ 3 pts Answer compared to an intuitive estimate which was vaguely explained**

+ 2 pts Answer compared to an intuitive estimate which was not justified

+ 1 pts Answer compared to an unreasonable estimate or wrong conclusion of the evaluation

+ 0 pts No reasonable attempt was made to evaluate the answer

1. drag coef is 0.5 for sphere
2. calculation error, off by factor of 10
3. this is only half the total time
4. this assumes drag force is constant the whole time

QUESTION 4

4 Q3continu 0 / 0

✓ **- 0 pts Correct**

any work listed on these sheets should have the mark included in the first part of question 3.

PRAKASH, SHIVESH | 1008693790 | SHIVESH.PRAKASH@MAIL.UTORONTO.CA

Family Name, Given Name (as on T-card) | Student Number | Email Address (for Gradescope) (@mail.utoronto.ca only)

PHY151H1F
Term Test 2
Friday, October 28, 2022
Duration: 45 minutes

Aids allowed: A pocket calculator with no communication ability and no calculus functions. A single hand-written aid-sheet prepared by the student, no larger than 8.5" x 11" (or A4), written on both sides. A hard-copy English translation dictionary. A ruler.

- **Completely turn off** any communication device you may have and place it in your bag (not in a pocket).
- **DO NOT separate the sheets of your question paper.** You can, however, *carefully* tear off the blank page at the end, as it does not have to be handed in.
- Before starting, please **PRINT IN BLOCK LETTERS your name, student number, and email address** at the top of this page.

You can write in pen or pencil.

There are 2 "short answer" questions worth 4 marks each and 1 "long answer" question worth 12 marks.

Answers are graded for clarity and completeness, as well as correctness, so show your work.

The long answer question has a "mulligan" option. You can upload to Gradescope by **midnight tonight** a one-page sheet summarizing what improvements you could have made on your long answer question. Do not submit a full solution, just commentary on what could have been improved in your specific response. You can get up to 2 additional points for doing this. See Quercus for more details. You can use any resources on this mulligan, including talking with other students after the test.

The total number of points available for the test is 20.

The long answer question is a modeling question. You get 4 marks for making and communicating your assumptions. You get 4 marks for solving the problem. You get 4 marks for evaluating your answer based on some alternative answer which you must briefly justify. The rubric is the same as was used of the modeling questions on the written homework assignments.

Possibly helpful information for this test:
$\pi = 3.14159$ is the ratio of the circumference to the diameter of a circle.
$g = 9.80$ m/s^2 is the acceleration due to gravity near the Earth's surface.
$\rho_{air} = 1.2$ kg/m^3 is the density of air at room temperature near the Earth's surface.
$\rho_{water} = 1.0 \times 10^3$ kg/m^3 is the density of water at room temperature.

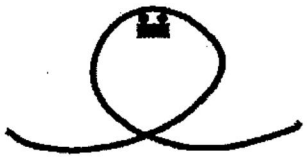
Common Prefixes:
k = "kilo-" = 10^3 c = "centi-" = 10^{-2} m = "milli-" = 10^{-3} μ = "micro-" = 10^{-6}

Air resistance may be neglected in all questions, unless otherwise stated.
All questions occur on Earth, unless otherwise stated.

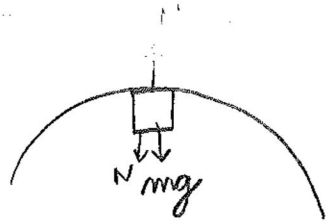
This Page Intentionally Blank

Question 1 [4 marks]

A 65 kg person rides a roller coaster while sitting on a bathroom scale. At the top of a loop-the-loop (pictured on the right) of radius 21 m, the roller coaster has a speed of 36 m/s. What does the bathroom scale read at the top of the loop? Answer in newtons (N).



Forces and variables: →



1. N in newtons, normal force between man and scale. This is what the scale reads.
2. m in kg, mass of man = 65 kg
3. g in m/s^2, acceleration due to gravity on Earth = 9.80 m/s^2
4. V in m/s, speed of rollercoaster = 36 m/s
5. R in m, radius of loop = 21 m

Solution: →

As the man is in circular motion, the net downwards force on him should provide the centripetal force, ie,

$$F_{net} = -\frac{mV^2}{R}$$

But from FBD → $F_{net} = -N - mg$

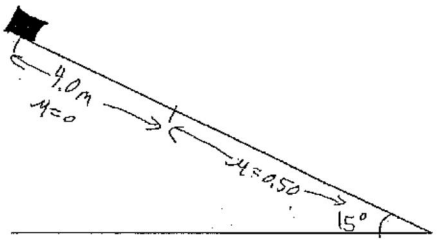
$$\Rightarrow -N - mg = -\frac{mV^2}{R} \Rightarrow N = -mg + \frac{mV^2}{R} = -(65)(9.80) + \frac{(65)(36)^2}{(21)}$$

$$\Rightarrow N \approx -637 + 4011 \approx 3400\,N.$$

Thus the bathroom scale reads 3400 N.

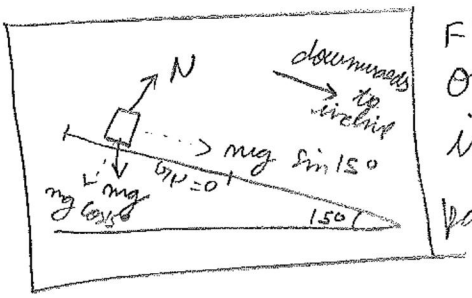
Question 2 [4 marks]

A 1.0 kg textbook slides down a road which is icy (treat as frictionless) at the top and rough (coefficient of kinetic friction is 0.50) the rest of the way. The road has a constant slope of 15 degrees. If the textbook was released from rest at the top of the icy patch, and the icy patch is 4.0 meters long, what total distance along the hill (including the icy patch) does the book travel before it comes to a stop?



While on icy path, the net acceleration of book is

$a_1 = \frac{mg\sin 15^\circ}{m} = g\sin 15^\circ \approx 2.5\ m/s^2$



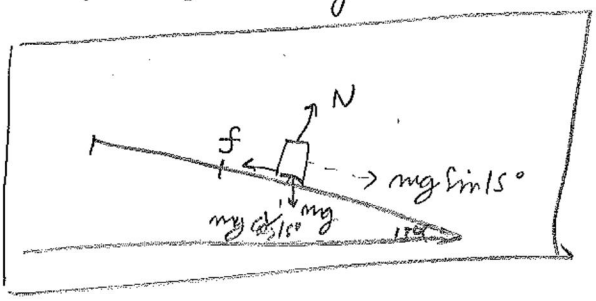
FBD on icy path

While travelling for 4 m on ice, the book gains a velocity of v_1 m/s. Using $v^2_{final} - v^2_{initial} = 2as$

$\Rightarrow v_1^2 - 0^2 = 2 \times 2.5 \times 4$

$\Rightarrow v_1 = 4.5\ m/s$

FBD on rough path.



While on the rough part, there is no acceleration perpendicular to the road so $N = mg\cos 15^\circ$.

$\Rightarrow$ the frictional force $f = \mu \times N$

$f = \mu mg\cos 15^\circ$

So net force on book downwards the roadies $\rightarrow$

$mg\sin 15^\circ - \mu mg\cos 15^\circ \Rightarrow$ acceleration $= g\sin 15^\circ - \mu g\cos 15^\circ = -2.2\ m/s^2$

This acceleration opposes the motion of the book.

Using $v^2_{final} - v^2_{initial} = 2as \Rightarrow 0^2 - 4.5^2 = 2 \times (-2.2)(s)$

$\Rightarrow s = 4.6$ m Thus the book travels 4.6 m on the rough path before coming to rest.

Total = 8.6 m

Question 3 [12 marks]

Modeling Question: A typical tennis ball has a mass of 0.058 kg and a diameter of 0.067 m. How far do you think a typical person can throw a typical tennis ball (on flat ground) if they aim the ball at an angle of 30 degrees above the horizontal (as in they throw it more horizontally than vertically, but it does have some initial upward velocity)? Do not ignore air resistance for this question. Remember to evaluate your result.

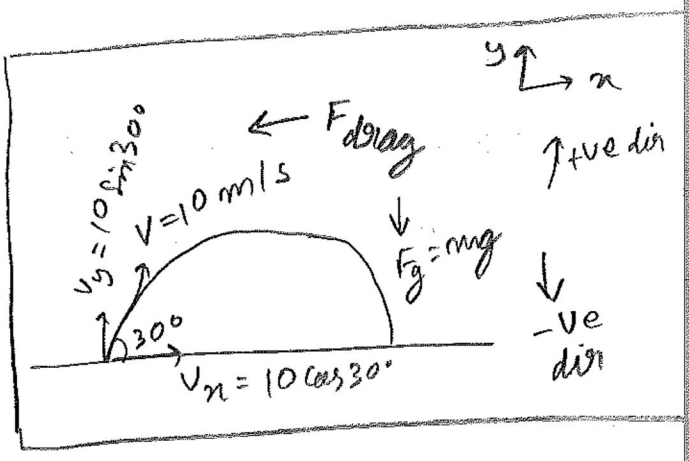
Assumptions: 1

1. The drag coefficient of a ball, C_d is assumed to be 0.24. source: Table 6.7 of Physics for Scientists and Engineers.
2. A typical person throws a ball with a velocity of around 10 m/s. This assumption is based on some baseball and cricket games I saw on T.V.
3. Since the velocity is quite small in the vertical direction, I assume no effect of the air resistance in this direction.

Solution:

The initial vertical velocity of the ball is $V_x = 10 \sin 30° = 5$ m/s

The time taken for the ball to hit the ground again is 8.



Using $V_{final} = V_{initial} + at$

Since gravity is the only force in y-dir

$-5 = 5 - gt \Rightarrow t = \frac{10}{g} = 1.0$ s 3

$F_{drag \text{ in } x \text{ dir}} = \frac{1}{2} C_d \rho A V^2 = \frac{1}{2} \times 0.24 \times 1.2 \times \pi \left(\frac{0.067}{2}\right)^2 \times (10 \cos 30)^2$

$= 0.04$ N $\Rightarrow a_x = \frac{0.04}{0.058} = 0.69$ m/s 2

Thus displacement in x-dir is (Using $s = ut + \frac{1}{2}at^2$)

Question 3 continued (if needed)

4

$$s = (10\cos 30)(1.0) + \frac{1}{2}(-0.69)(1.0)^2$$

$$s = 8.32\ m$$

Thus the horizontal distance covered by the ball is 8.32 m.

Justification →

This value is coherent with multiple real life situations. Most people can throw a tennis ball upto 10 m far at maximum. While playing a game of catch with my dad, he generally can't throw the ball over our pool, which is 6.5 m long. He is 55 years old, so I would assume an average person to throw a ball upto 8 m far. Thus, my answer is in agreement with real life scenarios and so it is justified.

ROUGH WORK (not marked)