PHY151H1F FALL 2022 phy151h1f test 3

Prakash Shivesh

TOTAL POINTS

18 / 20

QUESTION 1

1 Question 1 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 Question 2 2 / 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.

you need to think about torque and angular momentum, 0.5/2 for physics.

EDIT: You got 0.5/2 for physics since this is a very confusing answer. I guess I can give you 1/2 since you did not talk about the torque at all or the momentum but you did talk about the vectors. For the clarity mark, I can bump it up to 1/2 since I guess you did fully answer the question but it is quite confusing to read since you didn't use any equations to explain.

QUESTION 3

3 Question 3 12 / 12

✓ + **6 pts marks for clearly and correctly evaluating the data with the appropriate equations and/or concepts**

+ **5 pts** marks for clearly and correctly evaluating the data with the appropriate equations and/or concepts but missing a minor detail
+ **4 pts** marks for correctly evaluating the data with the appropriate equations and/or concepts, but missing a major detail
+ **3 pts** marks for using appropriate equations and/or concepts but incorrectly evaluating the data
+ **2 pts** marks for an attempt at analyzing the data using inappropriate equations and/or concepts which nonetheless demonstrates some understanding of relevant physics. A well done sketch of the situation and any other relevant representation (force diagram, velocity-time graph if not already provided, energy bar chart), gets 2 marks
+ **1 pts** marks for any correct statement. A well done sketch of the situation, or any other relevant representation (force diagram, velocity-time graph if not already provided, energy bar chart), gets 1 mark

✓ + **3 pts marks for clearly and quantitatively answering the question based on the data**

+ **2 pts** marks for having a concluding sentence that is relevant to the question
+ **1 pts** marks for at least underlining or otherwise drawing attention to the final answer

✓ + **3 pts marks for correctly addressing the effect of the uncertainties on the analysis**

+ **2 pts** marks for making reasonable statements about the magnitude of the uncertainties
+ **1 pts** marks for mentioning the uncertainties in

some nontrivial fashion

+ **0 pts** nothing submitted

QUESTION 4

4 Question 3contin. **0 / 0**

✓ **+ 0 pts** **Mark is on "previous page".**

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PHY151H1F
Term Test 3
Friday, November 25, 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.

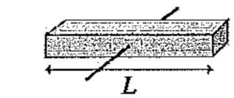
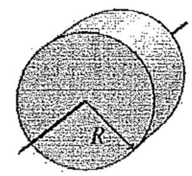
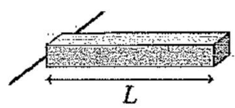
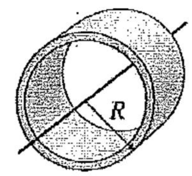
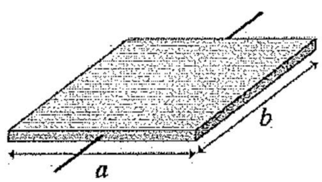
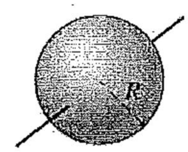
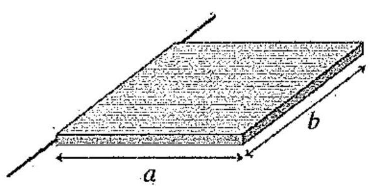
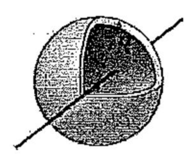
The long answer question is a data analysis question. You get 6 marks for solving the physics problem. You get 3 marks for having a clear and quantitative answer to the question. You get 3 marks for discussing the uncertainty of your final answer. The rubric is the same as was used of the modeling questions 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.
$g = 9.80\ \mathrm{m/s^2}$ is the acceleration due to gravity near the Earth's surface.
$\rho_{air} = 1.2\ \mathrm{kg/m^3}$ is the density of air at room temperature near the Earth's surface.
$\rho_{water} = 1.0 \times 10^3\ \mathrm{kg/m^3}$ 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.
The next page has some common moments of inertia, taken from the textbook.

TABLE 12.2 Moments of inertia of objects with uniform density

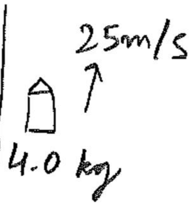
Object and axis	Picture	I	Object and axis	Picture	I
Thin rod, about center		$\frac{1}{12}ML^2$	Cylinder or disk, about center		$\frac{1}{2}MR^2$
Thin rod, about end		$\frac{1}{3}ML^2$	Cylindrical hoop, about center		MR^2
Plane or slab, about center		$\frac{1}{12}Ma^2$	Solid sphere, about diameter		$\frac{2}{5}MR^2$
Plane or slab, about edge		$\frac{1}{3}Ma^2$	Spherical shell, about diameter		$\frac{2}{3}MR^2$

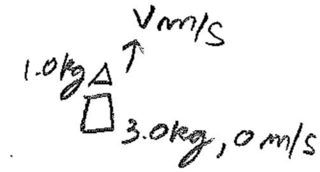
Question 1 [4 marks]

A 4.0 kg toy rocket is going up at a speed of 25 m/s when it explodes into two pieces. The larger 3.0-kg-piece is momentarily at rest immediately after the explosion, while the smaller 1.0-kg-piece is moving up very fast. How much chemical energy was converted into kinetic energy in the explosion?

By conservation of momentum:
as no force provides significant impulse (explosion time is negligible)

$(4.0)(25) = (3.0)(0) + (1.0)(V)$





$100 = 0 + V$

$\Rightarrow V = 100 \text{ m/s}$

Initial kinetic energy of system (just before explosion):

$KE_i = \frac{1}{2} \times (4.0)(25)^2 = 1250 \text{ J}$

Final kinetic energy of system (just after explosion):

$KE_f = \frac{1}{2} \times (3.0)(0)^2 + \frac{1}{2}(1.0)(100)^2 = 5000 \text{ J}$

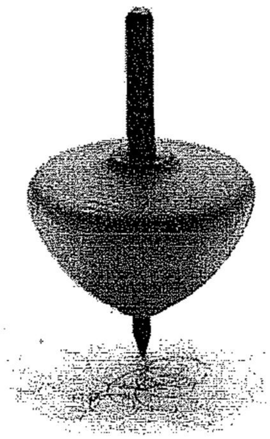
Since no external force does any work on the system, this excess energy must be provided by the chemical energy:

$\Delta U_{CHEM} = KE_f - KE_i = 5000 - 1250 = 3750 \text{ J}$

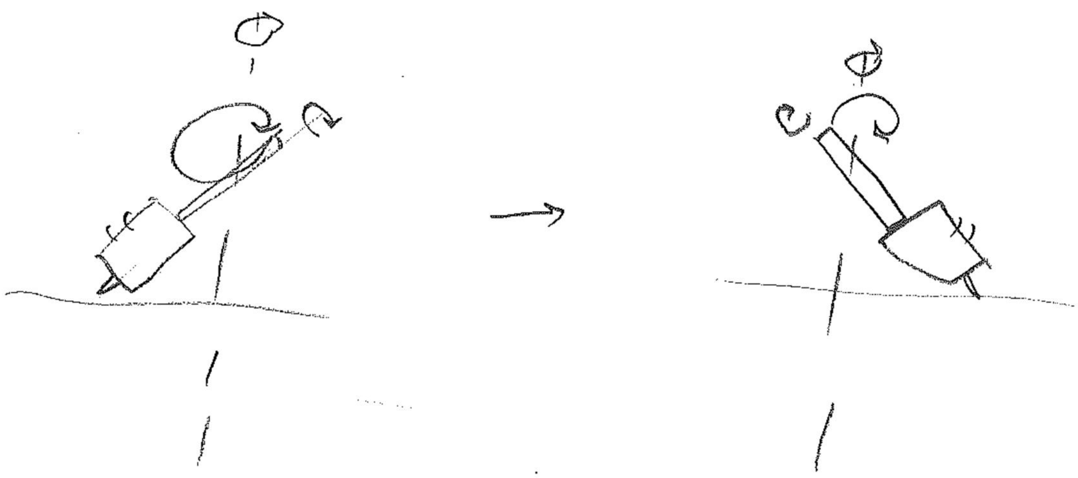
Thus 3750 J of chemical energy was converted to kinetic energy during this collision.

Question 2 [4 marks]

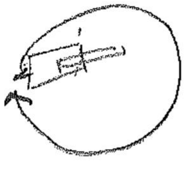
A spinning toy top, pictured on the right, is rotating clockwise when viewed from above. If you tap the top of the spinning top with a small force pointed north, what will the spinning top do as a result of this force? You must explain your answer to get any credit..



I expect the top to go in a gyroscopic type of motion. it keeps spinning about the same axis, but the axis itself starts a circular motion in the clockwise direction.



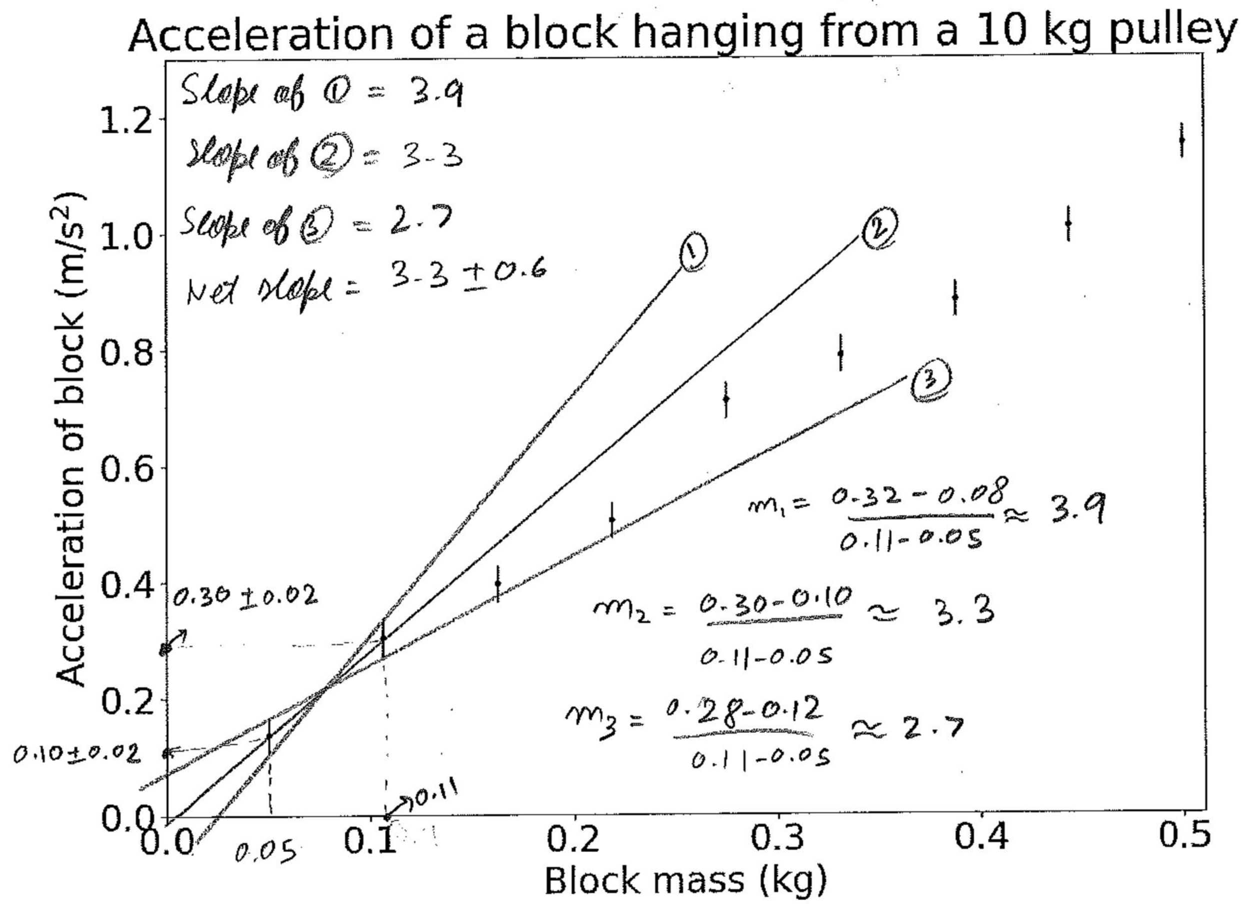
This happens because the force applied by us pushes the top into this motion, its rotation keeps it going in this motion. It spin about its own axis and rotates about the dotted line



Top view of motion of bottom of top

Question 3 [12 marks]

Data Analysis Question: A 10.0 kg pulley of radius 35.0 cm has a low-mass rope wrapped around it. Various small masses are attached to the other end of the rope and allowed to fall. The acceleration of each mass is measured. The data is plotted below. If the moment of inertia of the pulley is assumed to be of the form $I = X M R^2$ where X is an unknown constant, and M and R are the mass and radius of the pulley, find X. What are your uncertainties of X?



Let $M = 10.0\,kg$ be mass of pulley.

Let m in kg be mass of block.

Let $R = 0.350\,m$ be radius of pulley

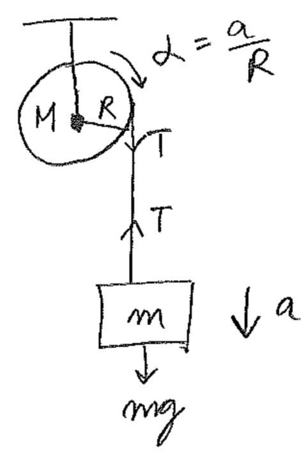
Let T in N be force of Tension in rope

Let a in m/s^2 be downwards acceleration of block

Let α in rad/s^2 be angular acceleration of pulley,

$\alpha = \frac{a}{R}$ as the rope does not slip on the pulley.

Let $I = X M R^2$ be moment of inertia of pulley.



Question 3 continued (if needed)

From force equation of block:

$$mg - T = ma \Rightarrow T = mg - ma$$

From torque equation of pulley:

$$TR = XMR^2 \cdot \frac{a}{R} \Rightarrow T = XMa$$

combining the two, $mg - ma = XMa$

$$\Rightarrow a(XM+m) = mg \Rightarrow a = \frac{mg}{XM+m}$$

Let us assume $m << XM$ to make the plot between a and m linear $\Rightarrow a = \frac{g}{XM}(m)$

Here $\frac{g}{XM}$ is slope of plot between a and m.

$$\Rightarrow \frac{g}{XM} = 3.3 \pm 0.6 \quad \text{(from graph)}$$

$$\Rightarrow X = \frac{9.8}{(3.3 \pm 0.6)(10.0 \pm 0.1)}$$

$$\Rightarrow X = \frac{9.8}{(3.3)(10.0)} = 0.30$$

from relative uncertainties

$$\frac{\Delta X}{X} = \frac{\Delta g}{g} + \frac{\Delta \text{slope}}{\text{slope}} + \frac{\Delta M}{M}$$

$$\Rightarrow \Delta X = X\left(\frac{0.6}{3.3} + \frac{0.1}{10.0}\right) = X(0.2)$$

$$\Rightarrow \Delta X = 0.2 \times 0.30 = 0.06$$

Thus $X = 0.30 \pm 0.06$

Please mark next page for Q3

Please Mark Q(3)

~~ROUGH WORK (not marked)~~

We formed our linear equation for $m << XM$, thus while drawing best fit lines we have taken only first 2 points. The uncertainities were calculated using the error bars in the graphical data, that is the source of our uncertainity.

In real life X is expected to be around 0.5, thus our value of 0.30 $\pm$0.06 is pretty close to it and is thus accurate. Even though we calculated X for small values of m, further analyses shows that this value is accurate for other data points too. The value for X calculated by us is completely in agreement with the data presented to us in the graph. The uncertainity calculated is in accordance with the error bars shown in graphical data.