PHY151H1F FALL 2022 PHY151H1F Test1

Prakash Shivesh

TOTAL POINTS

18 / 20

QUESTION 1

1 Q1 **3.5 / 4**

- **0 pts** Correct, coherent, and complete solution
- **0.5 pts** One minor mistake
- **1 pts** Demonstrates some pertinent logic but there is one major mistake or the solution is incomplete
- **1.5 pts** Any correct statement is written
- **2 pts** Entirely incorrect or missing logic

✓ **- 0.5 pts Complete but slightly confusing or clear but missing something important**

- **1 pts** Not coherent, not complete, or only somewhat coherent and complete
- **1.5 pts** Only somewhat coherent or only somewhat complete
- **2 pts** Not coherent and not complete

1 You should show how the total distance and total time are calculated.

QUESTION 2

2 Q2 **4 / 4**

✓ **+ 2 pts Accuracy and logic**

- **+ 1.5 pts** Accuracy and logic
- **+ 1 pts** Accuracy and logic
- **+ 0.5 pts** Accuracy and logic
- **+ 0 pts** Accuracy and logic

✓ **+ 2 pts Coherent and complete explanation**

- **+ 1.5 pts** Coherent and complete
- **+ 1 pts** Coherent and complete explanation
- **+ 0.5 pts** Coherent and complete
- **+ 0 pts** Coherent and complete explanation

QUESTION 3

3 Q3 **10.5 / 12**

- **0 pts** Correct logic & results
- **1 pts** one minor mistake
- **2 pts** One major physics mistake
- **3 pts** Major physics mistake and 1 or more minor mistakes
- **4 pts** Some pertinent logic, but mostly incorrect
- **5 pts** Incorrect/incomplete, but includes one correct statement about physics
- **0 pts** Coherent and complete explanation
- **1 pts** unorganized solution or lacks some explanation
- **1 pts** sketch of the problem is unclear/incorrect/missing
- **2 pts** Sketch is incomplete/unclear/incorrect, but explanation is mostly coherent and mostly complete
- **2 pts** Good sketch, but explanation is lacking
- **3 pts** Good sketch of problem, but explanation is incoherent/incomplete
- **4 pts** Explanation isn't coherent/complete, but the sketch and relevant information is mostly correct
- **4 pts** somewhat incoherent/incomplete explanation and unclear sketch of the problem set up
- **1 pts** need to state the formula used before plugging in the numbers

✓ **- 1.5 pts some minor mistakes**

- **1 pts** incorrect physics formula used
- **2 pts** Did not provide a clear set of steps leading to the final answer
- **3 pts** logical train of thought towards the answer is incorrect
- **3 pts** solution is incomplete
- **5 pts** Does not offer a significant attempt at solving the question
- **2 pts** Unjustified Assumption made
- **1.5 pts** Missing/unclear numerical final answer
- **3 pts** Multiple physics mistakes
- **1 pts** Does not uniquely define all necessary variables

- **3 pts** Solution is unclear/hard to follow
- **2 pts** Calculated the wrong quantity
- **2 pts** missing calculations of necessary quantities
- **5 pts** Sketch and explanation is mostly empty

there seems to be a rounding error somewhere. (answer should be -118 m/s^2). There is also a missing minus sign in the final answer

QUESTION 4

4 Q3cont. 0 / 0

✓ **- 0 pts** **any work on this page should have been included with the mark for 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 1
Friday, October 7, 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.

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

An object moves in a straight line with a position given by the function $s(t) = B\,t^5$ where B is an unknown constant. At time t = 1 second the object is moving 0.60 m/s. What is the average speed of the object during the first 1 second of motion (from t = 0 seconds to t = 1 second)?

The position is given by $s(t) = Bt^5$, we know that velocity is given by $V(t) = \frac{d(s(t))}{dt} = \frac{d}{dt}(Bt^5) = 5Bt^4$

It is given that velocity at 1 sec is 0.60 m/s $\Rightarrow V(1) = 0.60$

$\Rightarrow 5B(1)^4 = 0.60$

$\Rightarrow B = \frac{0.60}{5} = 0.12$

The average speed is defined by $V_{AVG} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$

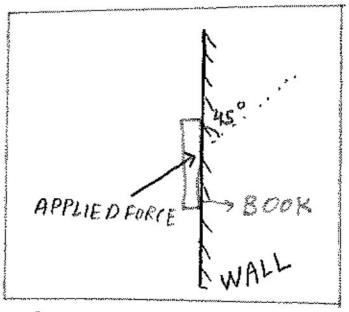
Therefore V_{AVG} from $t=0$ till $t=1$ $= \frac{s(1)}{1s} = \frac{B(1)^5}{1} = 0.12$ m/s

1

Thus the average speed of the object from $t=0s$ to $t=1s$ is 0.12m/s.

Question 2 [4 marks]

You push a 1.0 kg book into a wall. Your push has a force of 8.8 N at an angle of 45 degrees (up and toward the wall). The book starts at rest. The coefficients of friction between the book and the wall are $\mu_s = 0.60$ and $\mu_k = 0.40$. Find the acceleration of the book.



ROUGH DIAGRAM

F (in N) → Applied push force
→ F_x, F_y are it's component

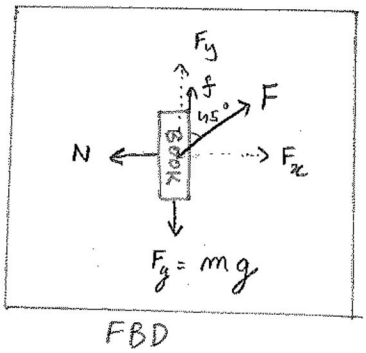
N (in N) → Normal force on book due to wall

F_g (in N) → Weight of book

m (in kg) → Mass of Book

g (in m/s²) → Acceleration due to gravity

f (in N) → Frictional force due to wall



FBD

Now, $|F_x| = |F_y| = |F| \sin 45° = |F| \cos 45°$

$|F_x| = |F_y| = 8.8 \times \frac{1}{\sqrt{2}} = 6.2$ N (to maintain significant figures)

There is no motion in y-dir so $F_{NET_y} = 0 \Rightarrow N = F_x = 6.2$ N

Now, $F_{NET_x} = F_y + f - F_g = 6.2 + f - (1.0)(9.80) = f + 6.2 - 9.8 = f - 3.6$

Maximum possible value of friction is $f_s = \mu_s \times N = 0.60 \times 6.2 = 3.72$ N

As maximum static friction is greater than net downwards force, f takes the value of 3.6 N and no net force acts on the book.

Therefore, the book's acceleration is 0 m/s².

Question 3 [12 marks]

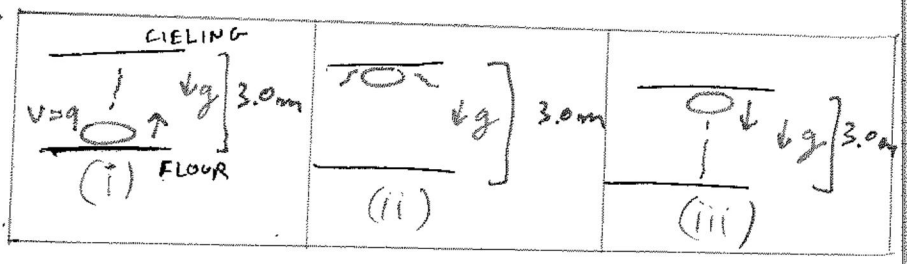
A pillow is thrown upward from the floor at a speed of 9.0 m/s. The pillow momentarily stops (it does not bounce) at the ceiling, 3.0 m above the floor, and then falls to the ground. The entire process (throw, stop, drop) takes 1.26 seconds. Find the average acceleration of the pillow while it was in contact with the ceiling.

This motion can be divided into three parts -

(i) from floor to ceiling, let's say it takes t_1 seconds.

(ii) interaction with ceiling, t_2 s

(iii) from ceiling to floor, t_3 s



We know, $t_1 + t_2 + t_3 = 1.26$ s.

(i) $v_{initial} = 9.0$ m/s distance $s = 3.0$ m $a = -g$ m/s^2

Using $s = ut + \frac{1}{2}at^2$ for motion (i)

$$3.0 = 9.0 \times t_1 - \frac{1}{2} \times 9.80 \times t_1^2$$

$$4.9t_1^2 - 9.0t_1 + 3.0 = 0$$

$$\Rightarrow t_1 = \frac{9.0 \pm \sqrt{(9)^2 - 4 \times 3 \times 4.9}}{9.8} = 1.4\text{ s or } 0.43\text{ s}$$

We consider the smaller time because this collision happens while the ball goes up $\Rightarrow t_1 = 0.43$ s

(iii) $v_{initial} = 0$ m/s distance $s = -3.0$ m $a = -g$ m/s^2

Using $s = ut + \frac{1}{2}at^2$ for motion (iii)

$$-3 = 0 - \frac{1}{2} \times 9.80 \times t_3^2 \quad \Rightarrow t_3^2 = \frac{6}{9.80} \Rightarrow t_3 = 0.78\text{ s}$$

Question 3 continued (if needed)

Since $t_1 + t_2 + t_3 = 1.26\,s$

$0.43 + t_2 + 0.78 = 1.26$

$\Rightarrow t_2 = 0.05\,s$

(ii) $V_{final} = 0\,m/s \qquad t_2 = 0.05\,s$

$V_{initial}$ can be found by using $V = u + at$ on motion (i)

$V = 9.0 - 9.80 \times t_1 = 9.0 - 4.2 = 4.8\,m/s$

Therefore $V_{initial} = 4.8\,m/s$

Average acceleration is defined as $a_{AVG} = \frac{\text{change in velocity}}{\text{Time Taken}}$

$\Rightarrow a_{AVG} = \frac{4.8 - 0}{t_2} = \frac{4.8}{0.05} = 96\,m/s^2$

Thus the avg acceleration while pillow was in contact with ceiling is $96\,m/s^2$

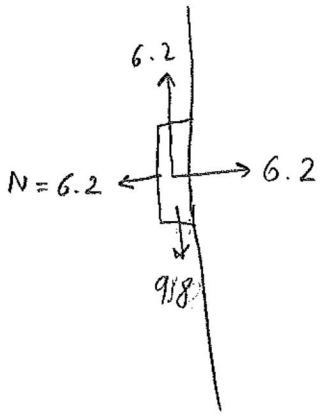
ROUGH WORK (not marked)

$S = BT^5$

$V = 5BT^4$

$5B = 0.6$

$B = \frac{0.6}{5} = 0.12$



$H = \frac{9 \times 9}{20}$

$\frac{2v}{g}$