Physics 5A - Winter 2021 Midterm 2

ZOE GLEASON

TOTAL POINTS

96 / 100

QUESTION 1

1 1 **4 / 4**

✓ **- 0 pts Correct**

- 4 pts Incorrect

QUESTION 2

2 2 **4 / 4**

✓ **- 0 pts Correct**

- 4 pts Incorrect

QUESTION 3

3 3 **4 / 4**

✓ **- 0 pts Correct**

- 4 pts Incorrect

QUESTION 4

4 4 **4 / 4**

✓ **- 0 pts Correct**

- 4 pts Incorrect

QUESTION 5

5 5 **0 / 4**

- 0 pts Correct

✓ **- 4 pts Incorrect**

QUESTION 6

6 6a **15 / 15**

✓ **- 0 pts Correct**

- 1 pts Incorrect force balance on block 1

- 2 pts Incorrect force balance on block 2

- 2 pts Incorrect equation for a

- 2 pts Incorrect equation for T

- 3 pts Incorrect value for a

- 1 pts Incorrect unit for a

- 3 pts Incorrect value for T

- 1 pts Incorrect unit for T

QUESTION 7

7 6b **15 / 15**

✓ **- 0 pts Correct**

- 7 pts Incorrect value plugged

- 3 pts Incorrect value for a

- 1 pts Incorrect unit for a

- 3 pts Incorrect value for T

- 1 pts Incorrect unit for T

QUESTION 8

8 7a **15 / 15**

✓ **+ 15 pts Correct: $$M\left(\frac{v^2}{R} + g\right)$$**

+ 0 pts Incorrect

QUESTION 9

9 7b **15 / 15**

✓ **+ 15 pts Correct $$M\left(g- \frac{v^2}{R}\right)$$**

+ 10 pts Partial credit: Correct magnitude but wrong direction

+ 0 pts Incorrect

QUESTION 10

10 7c **10 / 10**

✓ **+ 10 pts Correct $$v=\sqrt{gR}$$**

+ 5 pts Partial credit: Answer not given in terms of the physical quantities (v,R) given in problem statement

+ 0 pts Incorrect

QUESTION 11

11 7d **10 / 10**

✓ **+ 10 pts Two possible correct answers: (1) Normal force becomes negative so the carpet must flip upside down to maintain circular motion (2) Can no longer maintain circular motion with the normal force provided.**

+ **5 pts** Partial credit: Right idea but poor/incomplete explanation

+ **0 pts** Incorrect

Midterm 2

Physics 5A, Winter 2021

Full Name (Printed) Zoe Gleason

Full Name (Signature) Zoe Gleason

Student ID Number 405308281

There is only one correct answer for each multiple-choice question. Clearly circle your multiple choice answers.

On free-answer questions, it is not sufficient to just present the final answer on any given problem. **You need to show all of your work** in your solution to justify your steps so that another person can understand how you arrived at the final answer. **All work must be your own and do not communicate with anyone about the exam.** Be prepared to defend anything you write down in a potential follow-up oral examination.

Your submitted exam on Gradescope must contain the same number of pages as the original exam packet and your solutions must be clearly written in the spaces below each question with your final answer clearly boxed or circled. (You may want to work on the problems on scratch paper, and when you are happy with your solution, write down your final solution in the space provided on the exam packet. But, do not turn in scratch paper on Gradescope – I will only grade what is written in the proper sections on the exam packet.)

Zoe Gleason

Have fun! Good luck!

Multiple-choice Section – Each question only has one correct answer.

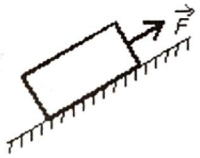
1. An elevator is moving with downward with constant acceleration and you are standing on a bathroom scale inside the elevator. The reading on the scale is

   A. equal to your true weight, mg.
   B. more than your true weight, mg.
   C. less than your true weight, mg.

C

2. A force $\vec{F}$ pulls a heavy stone block along a rough steel plate, as shown below for two cases. The magnitude of the applied force $\vec{F}$ is the same for both cases. The normal force in (ii), as compared with the normal force in (i) is:

(i)



(ii)

   A. the same
   B. greater
   C. less
   D. less for some angles of the incline and greater for others
   E. less or greater, depending on the magnitude of the applied force F

C

3. As you are driving on the freeway, a flying insect smashes head-on against the front of your car.

   True or False. The force your car exerts on the insect is larger than the force the insect exerts on the car.

   A. True
   B. False

   B

4. As you are driving on the freeway, a flying insect smashes head-on against the front of your car.

   True or False. The acceleration experienced by the insect is equal in magnitude but opposite in direction to the acceleration experienced by the car.

   C. True
   D. False

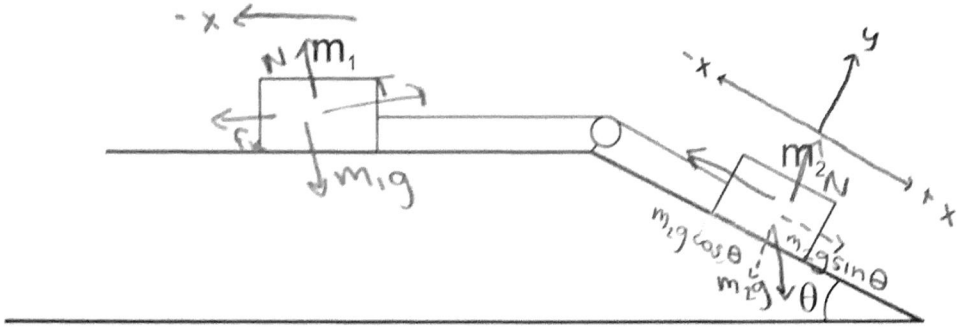
   D

5. True or False. Whenever *any* physical force, let's call it $\vec{T}$, acts on an object, that object will move with acceleration $\vec{a}$ in response to that force, according to $\vec{T} = m\vec{a}$.

   A. True
   B. False

   A

6. Two boxes with identical masses equal to $40\ kg$ are connected by a string and pulley as shown in the figure below. The angle of the incline is 30^o, and both boxes experience a sliding frictional force with $\mu_k = 0.15$. Use $g = 9.8\ m/s^2$ for the acceleration of gravity.



- 6a) What is the **acceleration** of the blocks and what is the **tension** in the cord?

[Hint: Remember that you need to solve for *two* things in part a): *acceleration* and *tension*.]
[Hint: Show all of your work and clearly box or circle your final answers.]

m_2

$\Sigma F_y = N - m_2 g\cos\theta$

$N = m_2 g\cos\theta$

$\Sigma F_x = m_2 g\sin\theta - f_k - T = m_2 a$

$f_k = \mu_k (m_2 g\cos\theta)$

$\Sigma F_{on\ m_1} = T - f_k = m_1 a$

$T = f_k + m_1 a$

$f_k = \mu_k N_1$

$T = \mu_k N_1 + m_1 a$

$\Sigma F_x = m_2 g\sin\theta - \mu_k (m_2 g\cos\theta) - (\mu_k N_1 + m_1 a) = m_2 a$

$40(9.8)(\sin 30) - 0.15(40 \times 9.8 \cos 30) - 0.15(40 \times 9.8) = 80a$

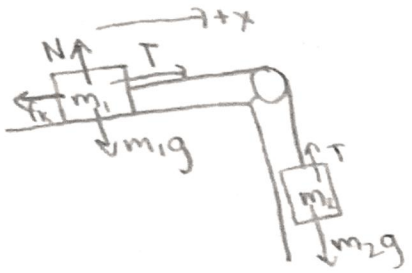
$a = 1.08\ m/s^2 \rightarrow \boxed{1.1\ m/s^2}$

$T = \mu_k m_1 g + m_1 a$

$= 40(0.15 \times 9.8 + 1.08)$

$= \boxed{102N}$

- 6b) What happens to the tension and acceleration if the angle of the incline goes to 90^o?



$\Sigma F_y = T = m_2(g-a)$

$\Sigma F_x = T - f_x = m_1 a$

$= m_2(g-a) - \mu_k N_1 = m_1 a$

$= 40(9.8) - 0.15(40 \times 9.8) = 40a + 40a$

$a = 4.165 \rightarrow$ 4.2 m/s² Acceleration will increase.

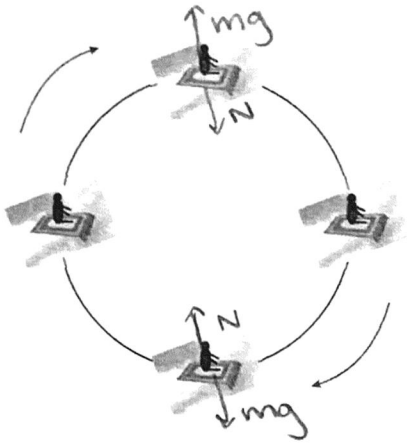
$T = m_2(g-a)$

$T = 40(9.8 - 4.165)$

$T =$ 225N Tension will increase

7. Jazmine sneaks out of her castle and decides to take Aladdin's magic carpet for an enchanting ride, by herself this time. Overexcited by the prospect of freedom and flight, Jazmine hurries onto the carpet and into a seated position. She shouts, "*Let's go Carpet, fly me around!*" The magic carpet takes off, but interprets the command too literally and flies "around and around" in repeating vertical loops of radius R with constant speed v.

   The carpet always stays upright and let's assume we can treat the carpet at all times as a perfectly flat, rigid, horizontal surface that Jazmine sits on. Let Jazmine's mass be M.



- 7a) Solve for the normal force the carpet exerts on Jazmine at the bottom of the vertical loop.

$$\Sigma F = N - mg$$

$$F = m \cdot a_c$$

$$a_c = v^2/R$$

$$\Sigma F = m\frac{v^2}{R}$$

$$m\frac{v^2}{R} = N - mg$$

$$\boxed{N = m\left(g + \frac{v^2}{R}\right)}$$

- 7b) Solve for the normal force the carpet exerts on Jazmine at the top of the vertical loop.

$\Sigma F = m\frac{v^2}{R}$ $\quad \Sigma F = mg - N$

$$\boxed{N = mg - m\frac{v^2}{R}}$$

- 7c) At what speed will the normal force at the top of the loop go to zero?

$$N = mg - m\frac{v^2}{R}$$

$$0 = mg - m\frac{v^2}{R}$$

$$mg = m\frac{v^2}{R}$$

$$g = \frac{v^2}{R}$$

$$v^2 = gR$$

$$\boxed{v = \sqrt{gR}}$$

- 7d) What happens to the normal force when the carpet goes faster than this speed [in part c)], and in few a words, explain what this means for Jazmine.

When the carpet goes past this speed, the normal force becomes negative.

This means that Jazmine will lose her seat on the carpet and fly off tangentially to the circle.