# Physics 218 – Exam II

**Fall 2017 (all sections)** **October 25$^{\text{th}}$, 2017**

Please fill out the information and read the instructions below, but **do not open the exam** until told to do so.

Rules of the exam:

1. You have 90 minutes (1.5 hrs) to complete the exam.
2. Formulae are provided to you with the exam on a separate sheet. Make sure you have one before the exam starts. You may *not* use any other formula sheet.
3. Check to see that there are 8 numbered (four double-sided) pages in addition to the scantron-like cover page. **Do not remove any pages**.
4. If you run out of space for a given problem, the last page has been left blank and may be used for extra space. Be sure to indicate *at the problem under consideration* that the extra space is being utilized so the graders know to look at it!
5. Calculators of any type are **not allowed**. Ensure that all your answers are in terms of the known variables given in the question.
6. Cell phone use during the exam is strictly prohibited. Please turn off all ringers as calls during an exam can be quite distracting.
7. Be sure to put a box around your $\boxed{\text{final answer(s)}}$ and clearly indicate your work. Credit can be given **only** if your work is legible, clearly explained, and labelled.
8. All of the questions require you show your work and reasoning.
9. Have your TAMU ID ready when submitting your exam to the proctor.

Fill out the information below and sign to indicate your understanding of the above rules

Name: ______________________________ UIN: ______________________________
(printed *legibly*)

Signature: ______________________________ Section Number: ____________________

Instructor (circle one): Akimov Dierker Melconian

## Short Problems:

A) The force, $F$, acting on a box is given as $F = \alpha x - \beta x^2 + \gamma x^3$, where $\alpha, \beta$ and $\gamma$ are known constants and $x$ is displacement in the direction of motion. Assuming that $F$ is the only force acting on it, find the work done on the box when the box is displaced by the force from position $x = 0$ to $x = x_0$. Express you answer in terms of $g, \alpha, \beta, \gamma$ and $x_0$ (not all may be necessary).

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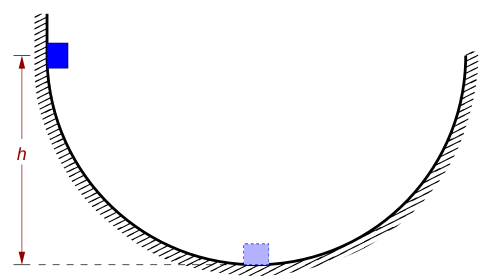
|---|---|---|
| 8.1 | | |
| 32.1 | | |

B) A box of mass $m$ is at the side of a half-cylinder which has a rough inner surface. The radius of the cylinder is known and equal to $h$. Once released from rest at the top, the box slides down and eventually comes to rest at the bottom of the cylinder due to friction. Find the work that friction does on the box during this motion. Express your answer in terms of $g, h$ and $m$ (not all may be necessary) and be sure to have the correct sign.

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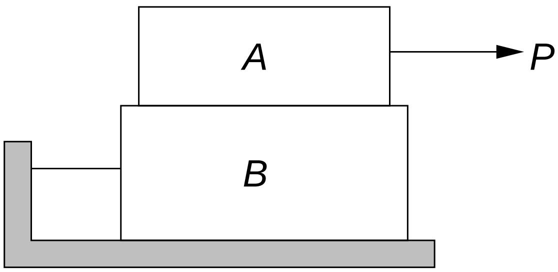
| 38.1 | | |
| 39.1 | | |

C) Block $B$, which has a mass $M$, is placed on a frictionless surface and connected to a wall using a light rope as shown below. Block $A$ of mass $m$ is placed on top and pulled with a force $P$ by a light string. There is friction between the two blocks, enough that neither of the blocks move. Draw free-body diagrams for both blocks.




| LO | S | U |
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| 23.1 | | |
| 23.2 | | |
| 24.1 | | |
| 24.2 | | |
| 26.1 | | |
| 26.2 | | |
| 26.3 | | |
| 29.1 | | |
| 29.2 | | |

D) In the previous problem, identify and indicate all action-reaction pairs.

| LO | S | U |
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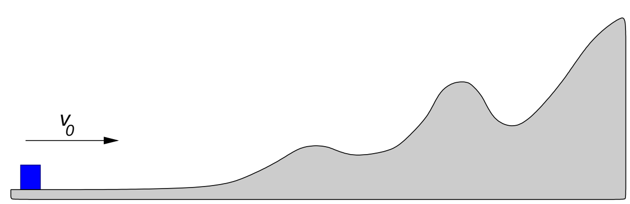
| 22.1 | | |
| 22.2 | | |

E) A stone of mass $m$ is moving towards a hill with a speed $v_0$. The shape of the hill is complex and not known. Friction everywhere is negligible. Find the maximum height that the stone will reach, expressing your answer in terms of $g, m$ and $v_0$ (not all may be necessary).

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| 3.1 | | |
| 34.1 | | |
| 38.2 | | |
| 40.1 | | |

F) A car of mass $m$ has a speed $v_0$ at $t = 0$ on a flat horizontal road when the driver slams on the brakes and locks the tires. The coefficient of kinetic friction between the tires and the road is $\mu_k$. Using work/energy considerations, find the distance that the car skids before coming to rest. Express your answer in terms of $g, m, v_0$ and $\mu_k$ (not all may be necessary).

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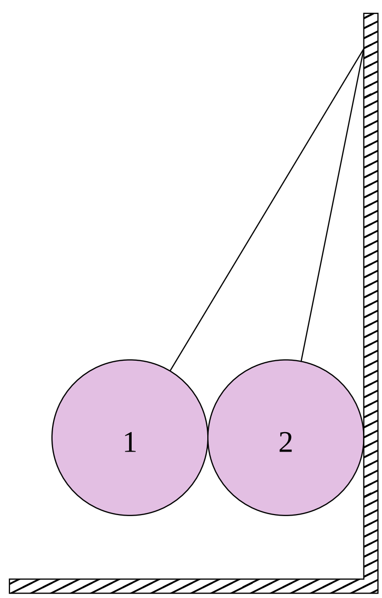
| 3.2 | | |
| 21.1 | | |
| 28.1 | | |
| 32.2 | | |
| 34.2 | | |
| 39.2 | | |

G) Two identical cylinders, each of mass $m$, are attached to a wall using two long wires as shown. The angles that the wires make with respect to the wall is $\alpha$ for the inner cylinder, and $\beta$ for the outer one. The cylinders are both at the same height above the ground. Draw a free-body diagram for each of the cylinders.




| LO | S | U |
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| 23.3 | | |
| 23.4 | | |
| 24.3 | | |
| 24.4 | | |
| 26.4 | | |
| 26.5 | | |
| 26.6 | | |

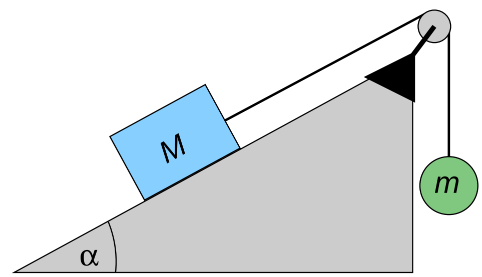
H) In the previous problem, identify and indicate all action-reaction pairs.

| LO | S | U |
|---|---|---|
| 22.3 | | |

**Prob 1** A block of mass $M$ is at rest on a rough surface which makes an angle $\alpha$ with the horizontal. A ball of mass $m$ is connected to the block via a massless rope passing over a frictionless massless pulley as shown. The coefficient of static and kinetic frictions between the block and the surface are $\mu_s$ and $\mu_k$ respectively. It is known that $\mu_s > \mu_k$ and that if something helps start the block to move, that it will not stop until it reaches the pulley. Express your answers to the questions below in terms of $g, M, m, \alpha, \mu_s$ and $\mu_k$ (not all may be necessary).

(a) Drawfree-body diagrams on or by the figure of the block and ball when the system is at rest.

(b) Find the tension in the rope when the system is at rest.




(c) Find the force of friction acting on the block when the system is at rest.

(d) For this part, the block $M$ has been jarred and is moving up the incline. What is its acceleration in this case?

(e) Find the force of tension when the block is accelerating up the incline.

| LO | S | U |
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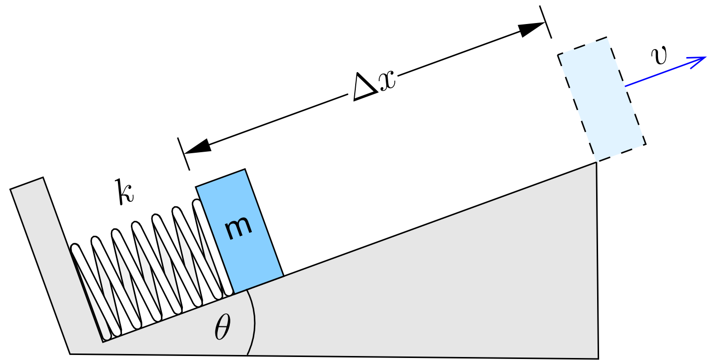
| 23.5 | | |
| 23.6 | | |
| 24.5 | | |
| 24.6 | | |
| 26.7 | | |
| 29.3 | | |
| 21.2 | | |
| 1.1 | | |
| 4.1 | | |
| 21.3 | | |
| 4.2 | | |
| 21.4 | | |
| 21.5 | | |
| 21.6 | | |
| 28.2 | | |
| 4.3 | | |

**Prob 2** A box of mass $m$ is pressed against (not attached to) a spring with a force constant $k$ on a frictionless incline which makes an angle $\theta$ with the horizontal. The spring is initially compressed by $\Delta x$, and the equilibrium length of the spring is equal to the length of the ramp. At $t = 0$, the box is released from rest. Express your answers to the follwing in terms of $g, m, \theta, k$ and $\Delta x$ (not all may be necessary).

(a) Find the speed of the box at the moment the spring reaches its equilibrium length.




(b) After the spring reaches its equilibrium position, the box leaves the ramp and is in projectile motion. What is the kinetic energy at the top of its trajectory?

| LO | S | U |
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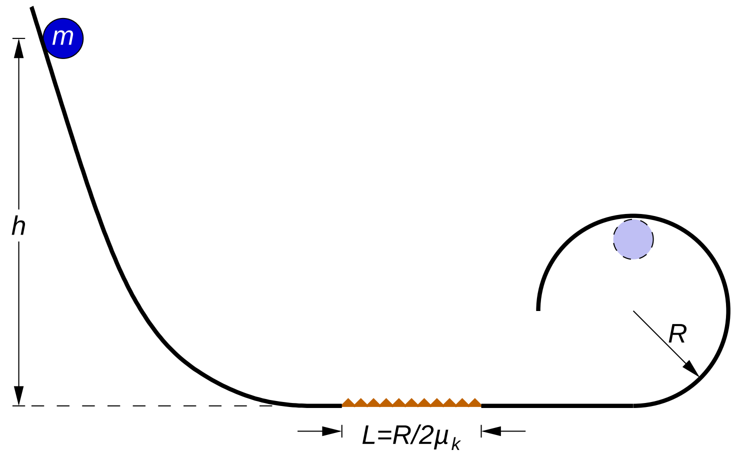
| 34.3 | | |
| 38.3 | | |
| 38.4 | | |
| 40.2 | | |
| 1.2 | | |
| 3.4 | | |
| 34.4 | | |

**Prob 3** A marble of mass $m$ is placed at the top of a gutter as shown below and released from rest. The surfaces are all frictionless except for a damaged part just before the circular part on the right side where the coefficient of friction is $\mu_k$ over a length $L = \frac{R}{2\mu_k}$, where $R$ is the radius of the circular part. When the marble reaches the top of the circular loop, it has a speed $v = \sqrt{gR}$ and does not lose contact with the gutter surface. Throughout the motion, the marble slides without rolling. Express your answers below in terms of $g, R, m$ and $\mu_k$ (not all may be necessary).

(a) Find the work done by friction as the marble crossed the rough patch before the gutter.




(b) Find the height, $h$, from which the marble should be released so that it reaches the speed $v$ at the top of the circle.

| LO | S | U |
|---|---|---|
| 3.5 | | |
| 21.7 | | |
| 28.3 | | |
| 32.3 | | |
| 3.6 | | |
| 34.5 | | |
| 38.5 | | |
| 39.3 | | |
| 40.3 | | |

**Extra Space:**