Nagy,

Tibor

Keep this exam **CLOSED** until advised by the instructor.

50 minute long closed book exam.

Fill out the bubble sheet: last name, first initial, **student number (PID)**. Leave the section, code, form and signature areas empty.

Two two-sided handwritten 8.5 by 11 help sheets are allowed.

When done, hand in your **test** and your **bubble sheet**.

Thank you and good luck!

Posssibly useful constant:

- g = 9.81 m/s^2

Posssibly useful Moments of Inertia:

- Solid homogeneous cylinder: $I_{CM} = (1/2)MR^2$
- Solid homogeneous sphere: $I_{CM} = (2/5)MR^2$
- Thin spherical shell: $I_{CM} = (2/3)MR^2$
- Thin uniform rod, axis perpendicular to length: $I_{CM} = (1/12)ML^2$
- Thin uniform rod around end, axis perpendicular to length: $I_{end} = (1/3)ML^2$

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Please, sit in row G.

1 pt Are you sitting in the seat assigned?

1.A◯ Yes, I am.

3 pt There are 149 steps between the ground floor and the sixth floor in a building. Each step is 17.1 cm tall. It takes 2 minutes and 33 seconds for a person with a mass of 68.8 kg to walk all the way up. How much work did the person do?
(in J*)*

2. **A**◯ 1.28×10^3 **B**◯ 1.85×10^3 **C**◯ 2.68×10^3 **D**◯ 3.89×10^3 **E**◯ 5.64×10^3 **F**◯ 8.18×10^3 **G**◯ 1.19×10^4 **H**◯ 1.72×10^4

3 pt What was the average power performed by the person during the walk?
(in W*)*

3. **A**◯ 3.74×10^1 **B**◯ 4.38×10^1 **C**◯ 5.13×10^1 **D**◯ 6.00×10^1 **E**◯ 7.02×10^1 **F**◯ 8.21×10^1 **G**◯ 9.61×10^1 **H**◯ 1.12×10^2

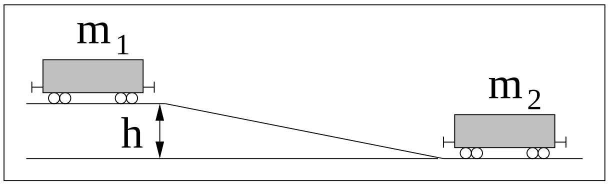
4 pt An airplane is flying with a speed of 247 km/h at a height of 4000 m above the ground. A parachutist whose mass is 93.4 kg, jumps out of the airplane, opens the parachute and then lands on the ground with a speed of 3.30 m/s. How much energy was dissipated on the parachute by the air friction?
(in MJ*)*

4. **A**◯ 3.04 **B**◯ 3.44 **C**◯ 3.88 **D**◯ 4.39 **E**◯ 4.96 **F**◯ 5.60 **G**◯ 6.33 **H**◯ 7.16

4 pt By what percent does the braking distance of a car increase, when the speed of the car increases by 18.9 percent? Braking distance is the distance a car travels from the point when the brakes are applied to when the car comes to a complete stop.

5. **A**◯ 7.47 **B**◯ 9.94 **C**◯ 1.32×10^1 **D**◯ 1.76×10^1 **E**◯ 2.34×10^1 **F**◯ 3.11×10^1 **G**◯ 4.14×10^1 **H**◯ 5.50×10^1

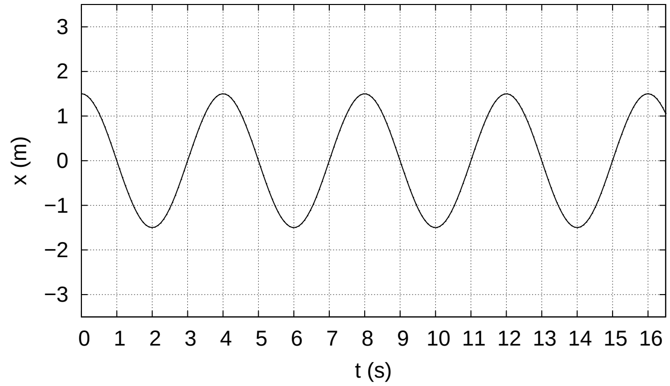
[*5 pt*] A railroad cart with a mass of $m_1 = 13.4$ t is at rest at the top of an $h = 11.8$ m high hump yard hill.



After it is pushed very slowly over the edge, it starts to roll down. At the bottom it hits another cart originally at rest with a mass of $m_2 = 17.0$ t. The bumper mechanism locks the two carts together. What is the final common speed of the two carts? (Neglect losses due to rolling friction of the carts. The letter t stands for metric ton in the SI system.)
(in `m/s`*)*

6. **A**◯ 6.71 **B**◯ 8.92 **C**◯ 1.19×10^{1}
D◯ 1.58×10^{1} **E**◯ 2.10×10^{1} **F**◯ 2.79×10^{1}
G◯ 3.71×10^{1} **H**◯ 4.94×10^{1}

The graph shows the x-displacement as a function of time for a particular object undergoing simple harmonic motion.

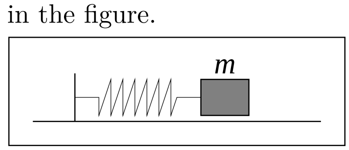


This function can be described by the following formula:
$x(t) = A\cos(\omega t)$, where x and A are measured in meters, t is measured in seconds, ω is measured in rad/s.

[*4 pt*] Using the graph determine the angular frequency ω of the oscillation.
(in `rad/s`*)*

7. **A**◯ 2.45×10^{-1} **B**◯ 3.55×10^{-1} **C**◯ 5.15×10^{-1}
D◯ 7.47×10^{-1} **E**◯ 1.08 **F**◯ 1.57
G◯ 2.28 **H**◯ 3.30

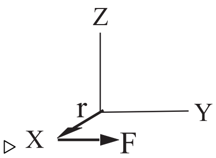
[*4 pt*] An object with a mass of $m = 1.27$ kg connected to a spring oscillates on a horizontal frictionless surface as shown in the figure.



The equation of the motion of the mass is given by
$x = 0.319\cos(1.01t)$
where the position x is measured in meters, the time t is measured in seconds. Determine the total mechanical energy of the mass spring oscillator.
(in `J`*)*

8. **A**◯ 6.59×10^{-2} **B**◯ 8.77×10^{-2} **C**◯ 1.17×10^{-1}
D◯ 1.55×10^{-1} **E**◯ 2.06×10^{-1} **F**◯ 2.74×10^{-1}
G◯ 3.65×10^{-1} **H**◯ 4.85×10^{-1}

4 pt An extended body (not shown in the figure) has its center of mass (CM) at the origin of the reference frame. In the case below give the direction for the torque τ with respect to the CM on the body due to force **F** acting on the body at a location indicated by the vector **r**.



9. **A**◯ X **B**◯ -X **C**◯ Y **D**◯ -Y **E**◯ Z **F**◯ -Z

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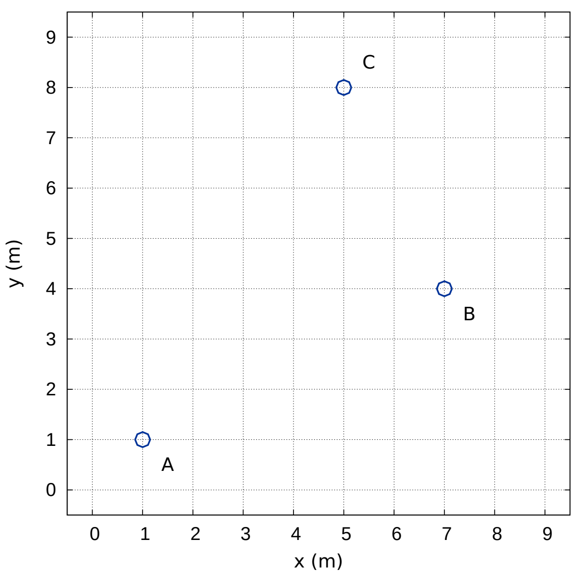
4 pt Three small objects are located in the x-y plane as shown in the figure. All three objects have the same mass, m = 1.77 kg.



What is the moment of inertia of this set of objects with respect to the axis perpendicular to the the x-y plane passing through location x = 3.00 m and y = 3.00 m? (The objects are small in size, their moments of inertia about their own centers of mass are negligibly small.)
(in `kg*m^2`*)*

10. **A**◯ 6.62×10^1 **B**◯ 7.49×10^1 **C**◯ 8.46×10^1 **D**◯ 9.56×10^1 **E**◯ 1.08×10^2 **F**◯ 1.22×10^2 **G**◯ 1.38×10^2 **H**◯ 1.56×10^2

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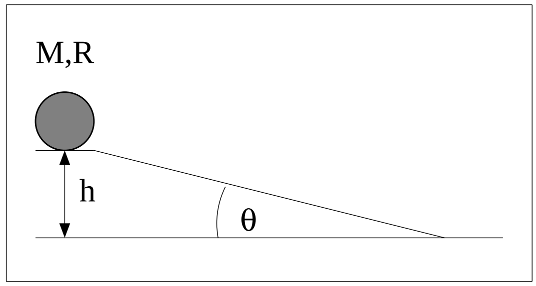
4 pt A solid, homogeneous cylinder with of mass of M = 2.75 kg and a radius of R = 18.3 cm is resting at the top of an incline as shown in the figure.



The height of the incline is h = 1.49 m, and the angle of the incline is $\theta = 14.3°$. The cylinder is rolled over the edge very slowly. Then it rolls down to the bottom of the incline without slipping. What is the final speed of the cylinder?
(in `m/s`*)*

11. **A**◯ 1.45 **B**◯ 1.81 **C**◯ 2.26 **D**◯ 2.83 **E**◯ 3.53 **F**◯ 4.41 **G**◯ 5.52 **H**◯ 6.90

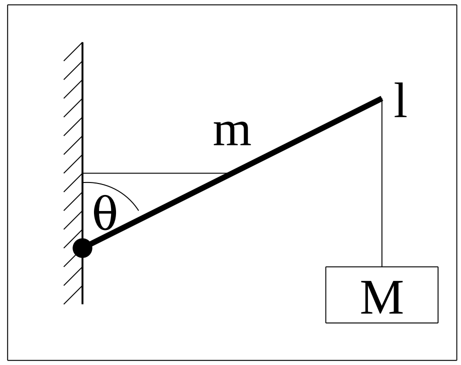
[*2 pt*] You ride your bicycle in the forward direction on a straight horizontal road. What is the direction of the velocity vector of your bicycle?

12. **A**◯ up to the sky
B◯ forward
C◯ to your right
D◯ down to the ground
E◯ backward
F◯ The velocity is zero.
G◯ to your left

[*2 pt*] What is the direction of the angular velocity vector of your wheels?

13. **A**◯ backward
B◯ to your left
C◯ to your right
D◯ forward
E◯ down to the ground
F◯ up to the sky
G◯ The angular velocity is zero.

A crate with a mass of M = 72.5 kg is suspended by a rope from the endpoint of a uniform boom. The boom has a mass of m = 126 kg and a length of l = 8.02 m. The midpoint of the boom is supported by another rope which is horizontal and is attached to the wall as shown in the figure.



[*3 pt*] The boom makes an angle of $\theta = 51.6°$ with the vertical wall. Calculate the tension in the vertical rope.
(in N*)*

14. **A**◯ 7.11×10^2 **B**◯ 8.89×10^2 **C**◯ 1.11×10^3
D◯ 1.39×10^3 **E**◯ 1.74×10^3 **F**◯ 2.17×10^3
G◯ 2.71×10^3 **H**◯ 3.39×10^3

[*3 pt*] What is the tension in the horizontal rope?
(in N*)*

15. **A**◯ 5.23×10^2 **B**◯ 7.59×10^2 **C**◯ 1.10×10^3
D◯ 1.60×10^3 **E**◯ 2.31×10^3 **F**◯ 3.35×10^3
G◯ 4.86×10^3 **H**◯ 7.05×10^3
