Physics 1D03 Test 2 **Version 2**

November 18, 2010

Duration: 80 min

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Name: Solutions

Student Number: ______________________

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Instructor: ____________________________

This test has 13 questions and 8 pages, plus a detachable formula sheet attached after page 8. Make sure your paper is complete.

Write your name and student number on this test paper before you begin. There are nine multiple-choice questions worth 2 marks each, and four long-answer problems worth 3 marks each.

Only the McMaster standard calculator is allowed. Notes are not permitted.

A sheet of formulae is attached at the end of this test. Do not write solutions on either side of this sheet; they will not be marked.

Answers for the multiple-choice questions (Part A) must be marked on the optical scan sheet, using an HB pencil. Before you begin, **print your name on the optical scan sheet and code your student number in the spaces provided on the scan sheet as well. You must code your student number correctly to receive full marks.**

You must also code your test version correctly in the Version column of the scan sheet to receive full marks.

Long-answer problems (Part B) are to be answered directly on this test paper in the spaces provided. Clear and complete solutions are required for full marks.

PLEASE DO NOT WRITE IN THIS AREA

1—9 (18)	10 (3)	11 (3)	12 (3)	13 (3)	Total (12)

Part A (multiple choice): Mark the letter corresponding to the best or most nearly correct answer on the optical scan sheet. Each correct answer is worth 2 marks. An incorrect answer or unanswered question counts as zero marks.

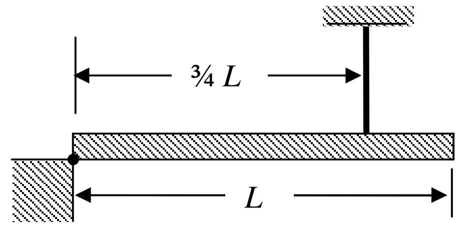
Before you begin, write your name on the test and scan card, code your student number and test version number. This test is Version 2.

1. The uniform beam of length *L* and weight *w* is supported in a horizontal position by a hinge at one end and a vertical cable at a distance ¾ L from the hinge. The tension in the cable will be

A) 1.5 *w*
B) 0.75 *w*
~~C) 1.33 *w*~~
D) 0.67 *w*
E) 0.5 *w*

$w\frac{L}{2} = \frac{3}{4}L \cdot F_T$

$F_T = \frac{2}{3}w$



2. To cause a car to start moving forward, the torque applied to one of the driving wheels should be represented by

A) a vector pointing to the driver's left
B) a vector pointing backwards
C) a vector pointing to the driver's right
D) a vector pointing forwards

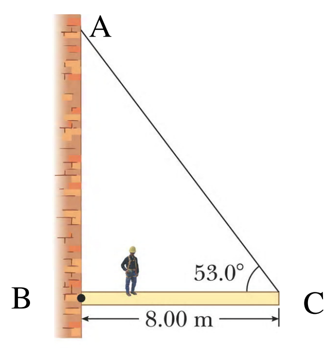
3. An a wheel spinning with 100 J of rotational kinetic energy can be stopped in 4 revolutions by a brake supplying a constant torque. To stop the wheel in one revolution would require a braking torque:

A) 16 times as large
~~B) 8 times as large~~
C) 4 times as large
D) twice as large

work $= \tau \Delta\theta$

4. For the diagram below, about which pivot point would a torque equation not involve the force of tension in the rope supporting the beam?

A) About C only
B) About B only
C) About A only
D) About A or C
E) About A or B

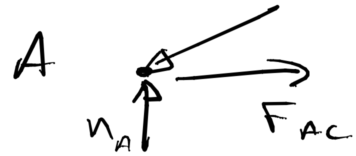


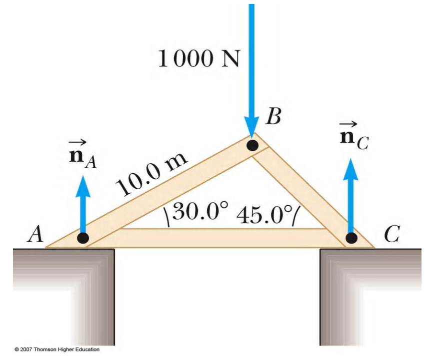
(a)

5. Several particles are bouncing around in a closed box. The total momentum of the particles plus the box will *not* remain constant if:

A) there are unbalanced forces exerted on the particles from an object outside the box.
B) the particles collide, and the collisions are inelastic.
C) the particles collide, and the collisions are elastic.
D) Any of the above.

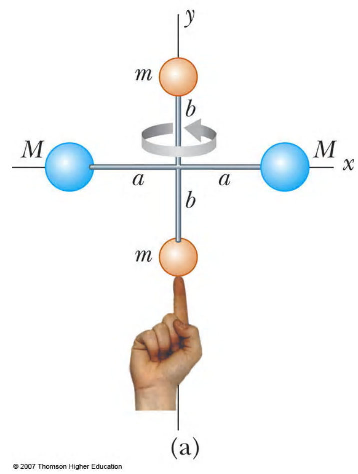
6. The truss shown in the diagram shown rests on smooth supports.
The member AC is in:





- ~~A) always zero force in AC~~
- B) tension
- ~~C) compression~~
- D) tension or compression, depending on the magnitude of n_A

7. Consider the system of four small spheres arranged as shown in the figure below, and rotating about the y-axis as shown. What would happen to the rotational kinetic energy of the system if both distances *a* and *b* were increased by a factor of two and the angular velocity kept constant?



- A) it would increase by a factor of 16
- ~~B) it would increase by a factor of 8~~
- C) it would increase by a factor of 4
- ~~D) it would increase by a factor of 2~~

$$I = \sum m r^2$$

8. If a heavy ball and a light ball are each kicked, one after the other, with equal impulses, then:

- ~~A) they will have equal momenta, and equal kinetic energies.~~
- B) they will have equal momenta, but the heavier ball will have less kinetic energy.
- C) they will have equal momenta, but the heavier ball will have more kinetic energy.
- D) they will have equal kinetic energies, but the heavier ball will have less momentum.
- E) they will have equal kinetic energies, but the heavier ball will have more momentum.

9. A person who weighs 500N jumps off of a bridge with a bungee cord tied to his ankle and drops a total of 20 m before bouncing back up. The unstretched length of the cord is 10 m. The spring constant of the cord is:

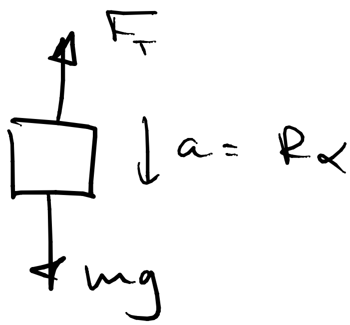
- ~~A) 400 N/m~~
- B) 200 N/m
- ~~C) 100 N/m~~
- D) 50 N/m
- E) 5 N/m

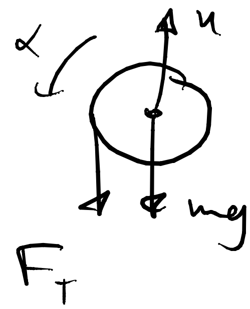
$$\frac{1}{2} k x^2 = |mg \Delta h|$$

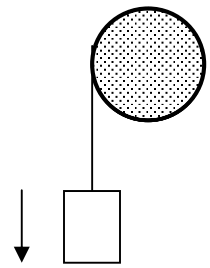
$(10 m)^2$ 500N 20m

Part B (Problems): Write a clear solution showing how the answer is obtained. Each problem is worth 3 marks.

10. A block of mass m = 15 kg is suspended from a light string, which is wrapped around a pulley. The pulley has radius R = 0.20 m, and moment of inertia (about its rotation axis) I = 2.0 kg·m^2. The block is released and causes the pulley to turn as it falls. The string does not slip while the mass falls. Calculate the angular acceleration of the pulley. Include free-body diagrams for both the block and the pulley.







$$RF_T = I\alpha \quad \cdots (2)$$

$$mg - F_T = ma$$

$$\Rightarrow mg - F_T = mR\alpha \quad \cdots (1)$$

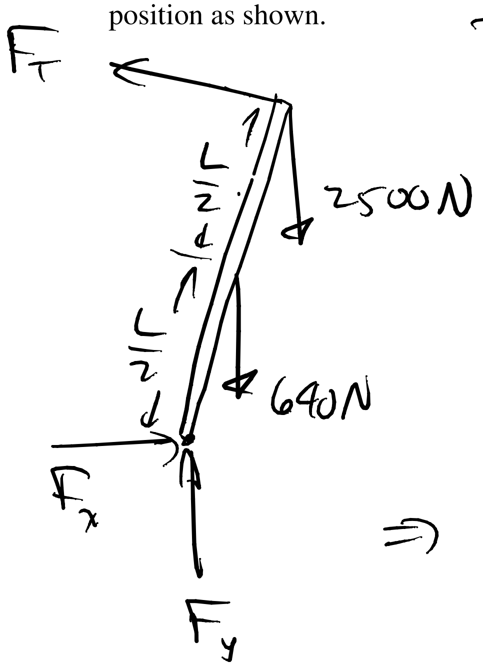
$$(1) + (2) \div R : \quad mg = \left(\frac{I}{R} + mR\right)\alpha$$

$$\Rightarrow \alpha = \frac{mg}{mR + I/R} = 11.3 \text{ rad/s}^2$$

$$\simeq 11 \text{ rad/s}^2$$

11. A 2500 N shark is supported by a cable attached to a 4.0 m uniform rod which has a weight of 640 N. The rod can pivot around the base, and has two ropes fixed to its top end.

a) Calculate the cable tension in the top cable needed to hold the system in position as shown.



Torques about hinge:

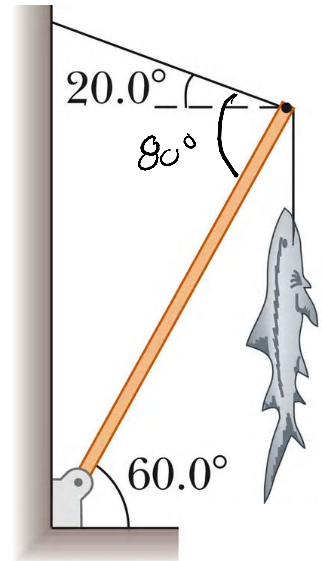
$$F_T \cdot L \cdot \sin 80^\circ$$

$$= L \cos 60^\circ \cdot 2500\,N$$

$$+ \frac{L}{2} \cos 60^\circ \cdot 640\,N$$

$$\Rightarrow F_T = 1432\,N$$

$$\simeq \underline{\underline{1.4\,kN}}$$



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b) Find the horizontal and vertical forces exerted by the hinge on the base of the rod.

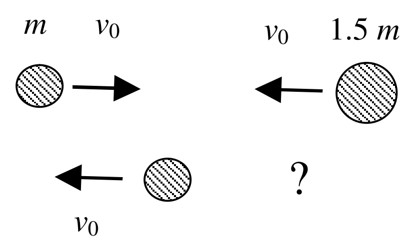
$$F_x = F_T \cos 20^\circ = 1345\,N \simeq \underline{\underline{1.3\,kN}}$$

$$F_y + F_T \sin 20^\circ = 640\,N + 2500\,N$$

$$\Rightarrow F_y = 2650\,N \simeq \underline{\underline{2.7\,kN}}$$

12. On a level, frictionless sheet of ice, a puck of mass m sliding to the right at speed v_0 collides with a puck of mass 1.5 m sliding to the left at the same speed v_0. After the collision, the first (lighter) puck is observed to be sliding back to the left at speed v_0. How much total kinetic energy of both particles is lost during the collision? Express your answer in terms of m and v_0.

$\longrightarrow$ positive



Let v_2 = velocity of larger puck after the collision.

Then $\vec{P}_{initial} = \vec{P}_{final}$

$$\Rightarrow \quad m v_0 + 1.5 m(-v_0) = m(-v_0) + 1.5 m v_2$$

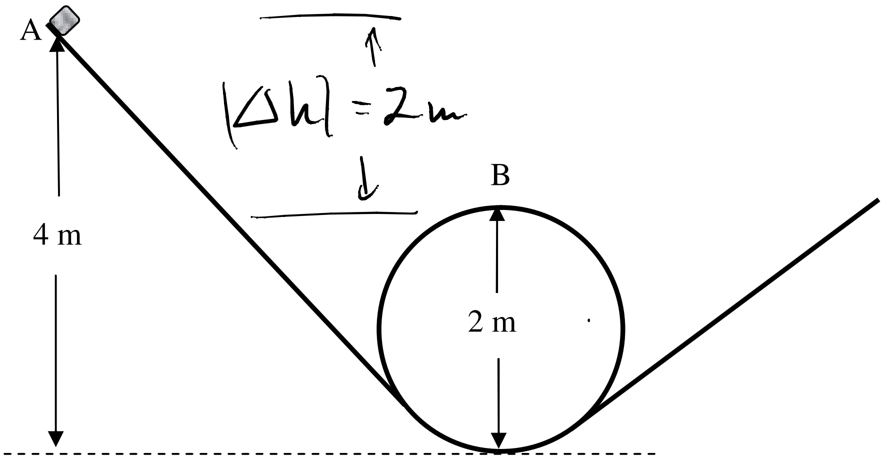
$$\Rightarrow \quad v_2 = \frac{1}{3} v_0$$

So,

$$K_{initial} - K_{final} = \frac{1}{2} m v_0^2 + \frac{1.5}{2} m v_0^2 - \frac{1}{2} m v_0^2 - \frac{1.5}{2} m \left(\frac{v_0}{3}\right)^2$$

$$= \frac{1.5}{2} m \cdot \frac{8}{9} v_0^2 = \underline{\underline{\frac{2}{3} m v_0^2}}$$

13. A block of mass 0.25 kg is released with zero initial velocity at point A on the frictionless track shown in the diagram. What is the normal force exerted on the block at point B?

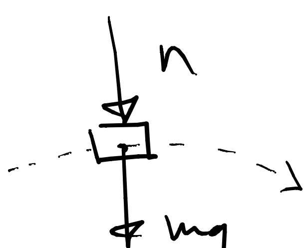


$$E_A = E_B \Rightarrow \frac{1}{2} m v_B^2 = mg \cdot 2m$$

$$v_B^2 = 39.2 \left(\frac{m}{s}\right)^2 , \quad v_B = 6.26 \, m/s$$

Forces at B:

$$mg + n = m\frac{v^2}{R} , \quad R = 1m$$



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

$$\Rightarrow n = m\left(\frac{v^2}{R} - g\right)$$

$$= \underline{\underline{7.35 N}} \approx \underline{\underline{7.4 N}}$$

THE END