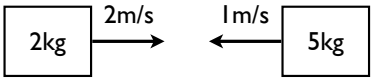
Sample Exam 2 Questions

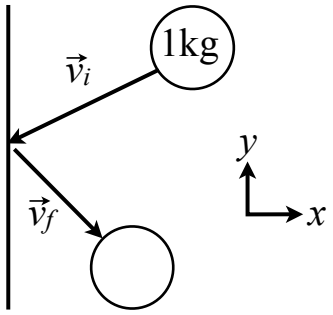
Physics 101, Fall 2016

[3] **1.** _____ A 2 kg block is moving to the right at 2 m/s, and a 5 kg block is moving to the left at 1 m/s. What is the total momentum $\vec{p}$ of both blocks together?



A) $1\,\text{kg m/s} \leftarrow$ **B)** $1\,\text{kg m/s} \rightarrow$
C) $9\,\text{kg m/s} \leftarrow$ **D)** $9\,\text{kg m/s} \rightarrow$

2. A 1 kg ball is moving with velocity $\vec{v}_i = (-3\hat{x} - 3\hat{y})\,\text{m/s}$ before it hits a vertical wall. Right after the collision, the ball's velocity is $\vec{v}_f = (1\hat{x} - 3\hat{y})\,\text{m/s}$.

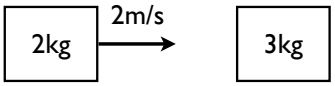


[3] (a) _____ What is the change in the ball's momentum $\Delta\vec{p}$?

A) $4\hat{x}\,\text{kg m/s}$ **B)** $-4\hat{x}\,\text{kg m/s}$
C) $4\hat{x} - 3\hat{y}\,\text{kg m/s}$ **D)** $-4\hat{x} + 6\hat{y}\,\text{kg m/s}$
E) Other (explain)

[2] (b) What is the impulse $\vec{J}$ of the wall on the ball?

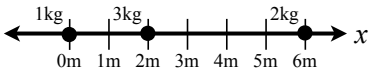
[3] **3.** _____ A 2 kg block is moving at 2 m/s when it collides with a 3 kg block at rest. The collision is *maximally inelastic*. How fast is the 3 kg block moving after the collision?



A) 0 m/s **B)** 0.8 m/s **C)** 1.3 m/s **D)** 1.6 m/s **E)** 2 m/s **F)** 3 m/s

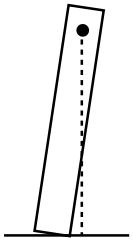
3 **4.** _____ Three masses sit on a number line as shown. Their center of mass is at the point marked

A) 1 m **B)** 2 m **C)** 3 m **D)** 4 m **E)** 5 m



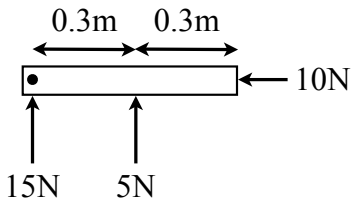
3 **5.** _____ This block has a center of mass at the location marked with the dot. Which is true?

A) The block feels a counterclockwise torque and will end up on its short end
B) The block feels a clockwise torque and will end up on its long end
C) The block feels no torque and remains balanced in that position

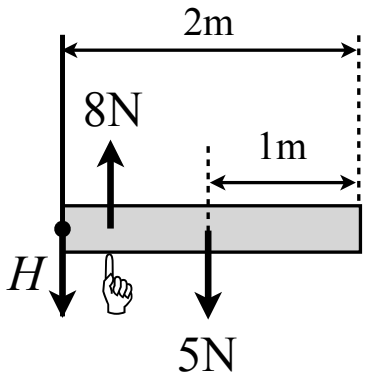


3 **6.** _____ The figure shows three forces applied to a door. Which force exerts the largest torque around the dot (the pivot)?

A) 5 N **B)** 10 N **C)** 15 N
D) Two or more exert the same torque. (Explain.)



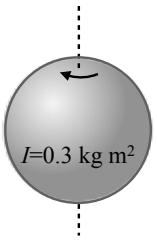
7. The figure shows a 2 m long rod which is attached to the wall by a hinge. The rod has a weight of 5 N which pulls downward at the center of the rod. The hinge exerts a downward force H, and a finger exerts an 8 N force upward between the other two forces, as shown. The rod is in equilibrium.



3 (a) What is the magnitude of the force H?

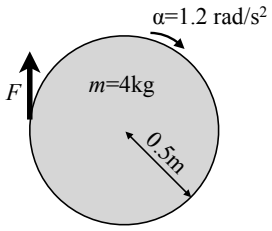
3 (b) How far away is the finger from the hinge? (Note: the figure is not drawn to scale.)

8. A sphere with moment of inertia $I = 0.3\,\text{kg} \cdot \text{m}^2$ spins around its axis, so that it goes around once every 3.0 s. Other than the spinning, the sphere is stationary. *(No, you don't need the radius of the sphere.)*



3 (a) _____ What is the sphere's angular velocity ω?
A) 0.33 rad/s **B)** 2.1 rad/s **C)** 3.0 rad/s **D)** 19 rad/s

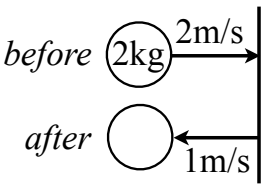
9. A 4 kg disk with radius 0.5 m starts at rest, and then a constant torque is applied for 3 s, causing it to accelerate at $\alpha = 1.2\,\text{rad/s}^2$. The moment of inertia of the disk is $I = 0.5\,\text{kg}\,\text{m}^2$.



3 (a) How many times does the disk go around during those 3 s? Give your answer in either radians or revolutions (but indicate which!)

3 (b) What is the torque on the disk?

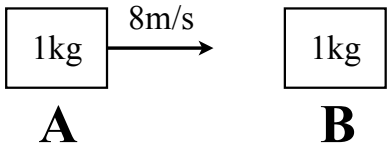
10. A 2 kg ball bounces off a wall. Before the collision it is moving at 2 m/s to the right; after, 1 m/s to the left.



3 (a) _____ The impulse $\vec{J}$ of the wall on the ball (which is equal to the change in the ball's momentum) is

A) $6\,\text{N}\cdot\text{s}$ to the left **B)** $2\,\text{N}\cdot\text{s}$ to the left
C) $2\,\text{N}\cdot\text{s}$ to the right **D)** $6\,\text{N}\cdot\text{s}$ to the right

11. A 1 kg block A moves at 8 m/s to the right towards a stationary 1 kg block B.



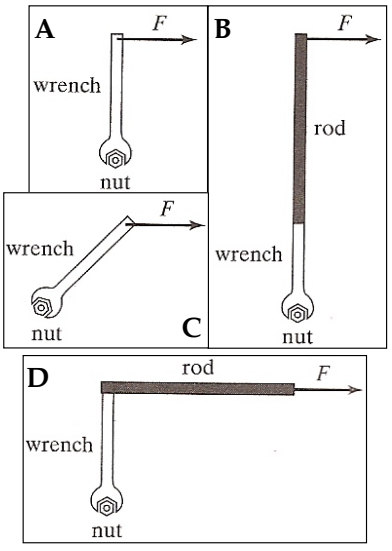
3 (a) What is the total momentum of both blocks?

3 (b) _____ Before the collision, the system's center of mass is
A) stationary
B) moving to the right at 4 m/s
C) moving to the right at 8 m/s

3 (c) _____ If the two blocks collide and the collision is maximally inelastic, what are the final speeds of the two blocks?

	Velocity of A	Velocity of B
A)	8 m/s ←	0 m/s
B)	8 m/s ←	8 m/s →
C)	4 m/s ←	4 m/s →
D)	0 m/s	8 m/s →
E)	4 m/s →	4 m/s →
F)	8 m/s →	8 m/s →

12. You are using a wrench and trying to loosen a rusty nut, using the same applied force F in four different configurations (as shown).

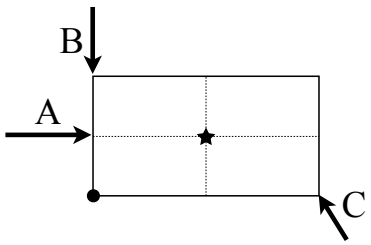


2 (a) _____ The torque in B is . . . the torque in A.
A) greater than **B)** equal to **C)** less than

2 (b) _____ The torque in C is . . . the torque in A.
A) greater than **B)** equal to **C)** less than

2 (c) _____ The torque in D is . . . the torque in A.
A) greater than **B)** equal to **C)** less than

13. Three forces act on a block as shown.

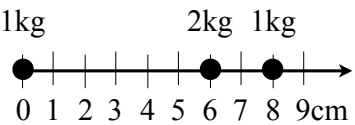


[2] (a) _____ If the pivot is at the star at the center of the block, the force B contributes
A) a clockwise torque
B) a counterclockwise torque
C) no torque

[2] (b) _____ If the pivot is at the dot in the bottom-left corner, the force B contributes
A) a clockwise torque
B) a counterclockwise torque
C) no torque

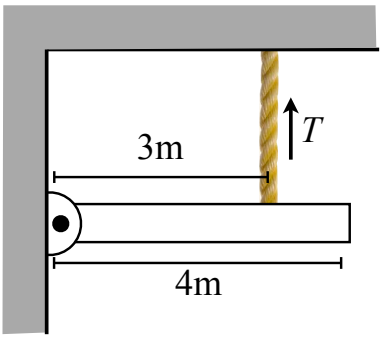
[+3] (c) **Extra credit:** Explain why this block cannot be in equilibrium, if the three forces point in the directions shown, no matter what the magnitudes of the forces are.

[3] **14.** _____ Three masses sit on a number line as shown. At what point on the number line does their center of mass lie?
A) 4 cm **B)** 5 cm **C)** 6 cm **D)** 7 cm



15. A 4 m long rod of uniform density and mass m is attached to a wall by a hinge, and to the ceiling by a rope with tension T which is attached 1 m from the right end of the rod. The rod is in equilibrium.

3 (a) Draw the three forces acting on the rod, at the points where the forces are acting. Call the hinge's force H. All forces are vertical. (The dotted lines are a meter apart.)

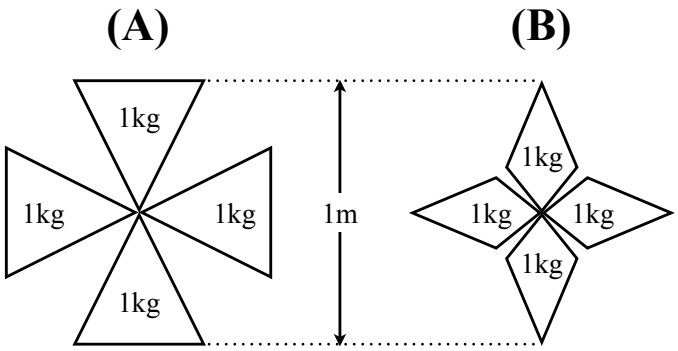


3 (b) _____ The tension T in the rope is

A) $\frac{1}{2}mg$ **B)** $\frac{2}{3}mg$ **C)** $\frac{3}{4}mg$ **D)** mg **E)** $\frac{4}{3}mg$

[3] **16.** The Earth spins around its axis once a day (86,400 s). The Earth's radius is $R = 6.4 \times 10^6$ m. What is the Earth's angular velocity ω?

[3] **17.** _____ The figure shows two fans; both fans have the same mass and radius. Which one has the greater moment of inertia I?



18. A wheel ($I = \frac{1}{2}MR^2$) with radius $R = 0.1$ m and a mass of 2 kg is rolling along a street at 5 m/s.

[3] (a) What is the angular velocity ω of the wheel?