

## Question 1 (2 points)

You want to write  $dm$  for a three-dimensional rod that has a given mass density  $\rho$  and a volume  $V$ . What is a general expression for  $dm$  in this case?

- $dm = \rho V$
- $dm = \rho/V$
- $dm = \rho dV$
- $dm = \rho/dV$

## Question 2 (2 points)

You want to write  $dm$  for a one dimensional rod that has a nonuniform mass density  $\lambda$  and a length  $L$ . The rod lies along the  $x$  axis. What do you do to get  $dm$ ?

- You use the idea that  $\lambda$  is a mass, so  $dm = d\lambda$ .
- You use the idea that mass can be found from linear mass density because mass = density/length. So when the mass is infinitesimally small, then you can write  $dm = \lambda/dx$ .
- You use the idea that mass can be found from linear mass density because mass = density \* length. So when the mass is infinitesimally small, then you can write  $dm = \lambda dx$ .
- You use the idea that mass can be found from linear mass density because mass = density \* length. So when the mass is infinitesimally small, then you can write  $dm = \lambda L$ , which is a constant.
- You can use the idea that  $\lambda$  is always equal to  $M/L$  no matter what, so  $dm = d\lambda * L$ , which is always a constant.

## Question 3 (2 points)

Consider the general integral for moment of inertia:

$$I = \int r^2 dm.$$

What is  $r$ ?

- The **scalar distance** from the axis to some mass element  $dm$ .
- The **vector displacement** that points from the axis to some mass element  $dm$ .
- The length of the rod.
- The distance from the axis to the end of the rod.

**Question 4 (2 points)**

Consider the general integral for moment of inertia:

$$I = \int r^2 dm.$$

What are the units of  $dm$ ?

- kg, since  $dm$  is just a tiny little bit of mass.
- seconds, since we always integrate with respect to time.
- $\text{kgm}^2$ , since it is a MOI integral, and those are the units of MOI.
- Unitless, as it is just a calculus placeholder.

**Question 5 (2 points)**

Consider the general integral for moment of inertia:

$$I = \int r^2 dm.$$

What is the best physical interpretation of the integrand:  $(r^2 dm)$ ?

- $(r^2 dm)$  is the moment of inertia of a tiny bit of mass ( $dm$ ) that is some distance  $r$  from the axis.
- [Math Processing Error] is the total mass of a tiny bit of mass ( $dm$ ) that is some distance  $r$  from the axis.
- $(r^2 dm)$  is the distance squared (in  $m^2$ ) of a tiny bit of mass ( $dm$ ) that is some distance  $r$  from the axis.
- It has no physical interpretation. It is just a necessary intermediate mathematical step.

**Question 6 (2 points)**

What are the units of  $\lambda dx$ ?

- No units. They're just calculus placeholders.
- $kg/m^3$
- $kg/m$
- $kg$
- $kg m^2$

**Question 7 (2 points)**

Consider a thin rod of nonuniform mass density given by  $\lambda = 4 + x^2$ , where  $x=0$  at the axis of rotation. The rod has a total length  $L = 4$  m and lies along the  $x$  axis. Which is the correct integral for finding the moment of inertia for an axis that passes through the rod at a length  $L/4$  from the left end?

$\int_{-1}^3 (4 + x^2) dx$

$\frac{M}{4} \int_0^4 x^2 dx$

$\frac{M}{4} \int_{-1}^3 x^2 dx$

$\int_{-1}^3 (4 + x^2) x^2 dx$

$\int_0^4 (4 + x^2) x^2 dx$

**Question 8 (2 points)**

Consider a thin rod of nonuniform mass density given by  $\lambda = 4 + x^2$ , where  $x=0$  at the axis of rotation, which is  $L/4$  from the left end. The rod has a total length  $L = 4$  m and lies along the  $x$  axis. Which is the correct integral for finding the total mass of the rod?

$\int_{-1}^3 (4 + x^2) dx$

$\frac{M}{4} \int_0^4 x^2 dx$

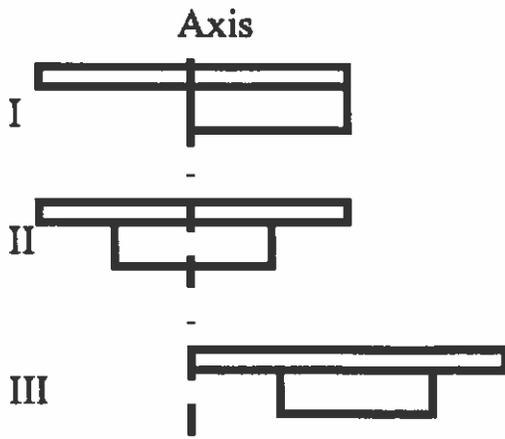
$\frac{M}{4} \int_{-1}^3 x^2 dx$

$\int_{-1}^3 (4 + x^2) x^2 dx$

$\int_0^4 (4 + x^2) x^2 dx$

**Question 9 (2 points)**

Review from Part 1: Which object has the largest moment of inertia about the axis shown assuming they have the same total mass?



- I
- II
- III
- Insufficient information.

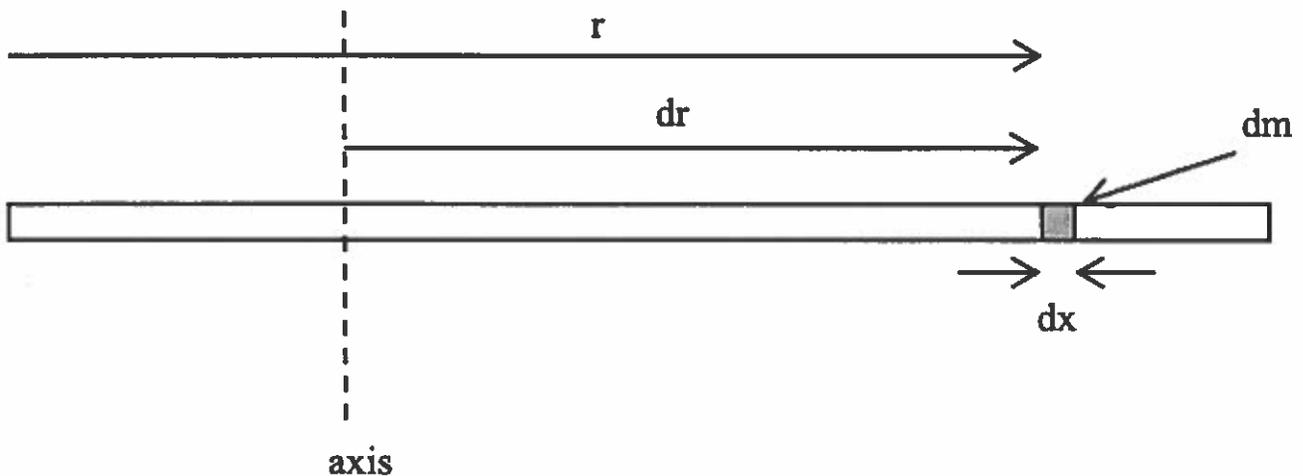
### Bonus Questions For Studying

These questions are here so you can use them to study for the exams.

They are worth bonus points, although no score above 100% can be earned.

#### Question 10 (0.5 points)

What is labeled incorrectly in this drawing?



- Only dm.
- Only dr.
- Only r.
- Only dx.
- More than one is incorrect.

**Question 11 (0.5 points)**

How might you find the total mass of a 1D object with known nonuniform mass density?

- $\int \lambda dm$
- $\int \lambda$
- $\int \lambda dx$
- $\int dx$
- More than one of the above is correct.

**Question 12 (0.5 points)**

Consider the following integral:

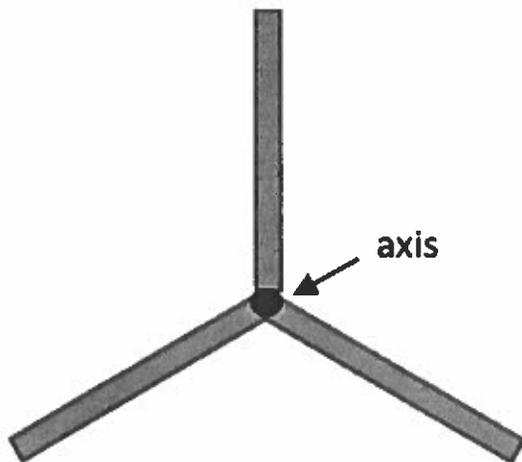
$$\int_0^L x^2 (A + Bx^3) dx.$$

Which of the following could be a correct physical interpretation of this integral?

- The total mass of a rod of nonuniform mass density  $(A + Bx^3)$  pivoted at the left end.
- The total mass of a uniform rod of length L.
- The moment of inertia of a rod of nonuniform mass density  $(A + Bx^3)$  pivoted at the left end.
- The total mass of a rod of nonuniform mass density  $(A + Bx^3)$  pivoted at the center.
- The moment of inertia of a rod of nonuniform mass density  $(A + Bx^3)$  pivoted at the center.

**Question 13 (0.5 points)**

Review from Part 1: A helicopter rotor has three blades that are essentially thin rods. Each one is 5.5 m long and has a mass of 240 kg. The rotor spins at 350 rev/min in the  $-z$  direction. Find its moment of Inertia assuming each blade can be modeled as a long rod.



- 350 kg m<sup>2</sup>
- 1815 kg m<sup>2</sup>
- 3630 kg m<sup>2</sup>
- 6490 kg m<sup>2</sup>
- 7260 kg m<sup>2</sup>

**Question 14 (0.5 points)**

General Review:

Choose ALL of the correct statements below. (Think of each like its own true/false question, and select it if it is true.)

- You get work by integrating force with respect to position
- If you integrate force with respect to time, you get the change in momentum
- Elastic collisions are ones in which mechanical energy is not conserved.
- Moment of inertia is a vector.
- The N2L equation of motion for a person in an elevator that is accelerating downwards is:  
 $n - mg = +ma$
- CoE problems do not need to use vectors
- CoLM problems do not need to use vectors