

Mechanics & Relativity

Dr Lily Asquith (Lily)

Week 2

Submit your workshop problem for marking by noon Friday

Y1 : Submitting Your Work For Marking

1. Identify the problem you have been asked to upload the solution for. For M&R, this is indicated with red text and a box around the question:

Problem 3

Two particles move along an x axis. The position of particle 1 is given by $x_1 = 6.00t^2 + 3.00t + 2.00$; the acceleration of particle 2 is given by $a_2 = -8.00t$ and, at $t = 0$, its velocity is $v_2 = 20\text{ms}^{-1}$. When the velocities of the particles match, what is their velocity?

For MM1, it is indicated with a key symbol.

3.  Suppose that $\mathbf{a} = i + 2j$, $\mathbf{b} = j + 3k$ and $\mathbf{c} = 2i - k$. Verify that

- (a) $\mathbf{a} \cdot (\mathbf{b} \times \mathbf{c}) = \mathbf{b} \cdot (\mathbf{c} \times \mathbf{a}) = \mathbf{c} \cdot (\mathbf{a} \times \mathbf{b})$,
- (b) $(\mathbf{a} \times \mathbf{b}) \times \mathbf{c} \neq \mathbf{a} \times (\mathbf{b} \times \mathbf{c})$,
- (c) $\mathbf{a} \times (\mathbf{b} \times \mathbf{c}) = (\mathbf{a} \cdot \mathbf{c})\mathbf{b} - (\mathbf{a} \cdot \mathbf{b})\mathbf{c}$.


2. Take a photo of your full worked solution for this problem (only this one).

0 : Nothing uploaded

- 1 : Something uploaded, but nothing that makes sense. If they have uploaded a blank page for example, or if they have written the question but not attempted an answer. Or, if they uploaded just the answer, with no working.
- 2 : An attempt has been made to solve the question, but it is not complete. For example (for the first M&R question), they might have done the integral right but not solved the quadratic, or vice versa.
- 3 : The correct answer is given.

3. Upload the file to canvas before 12 noon on Friday.

Due Friday by 12:00 Points 3 Submitting a file upload

MandR-2021-W1-Kinematics.pdf 

File upload Office 365

Upload a file, or choose a file you've already uploaded.

 Upload file  Use Webcam

+ Add another file

Click here to find a file you've already uploaded

Comments...

Cancel

Submit assignment

The upload will automatically be associated with you – no need to put your name or candidate number on it.

4. Await your grade. You will be awarded a mark out of 3 (within the following week, but probably very quickly.

The workshop problems (1 per week for 10 weeks) = 10% of your final mark

Adaptive practice

There are three adaptive practice assignments for this week: 2.1, 2.2, 2.3.

The adaptive practice quizzes (3 per week for 11 weeks) = 10% of your final mark.

But more importantly, they are exactly what you need to do to get a grasp of the topics covered in this module.

The reason for this module is to prepare you for what is next.

Vectors

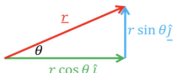
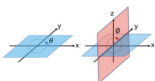
This week's topics:

1.1 Intro to vectors for physics

1.2 Addition

1.3 Multiplication

Key formulae for the toilet door

1.1 Unit vector notation	$\mathbf{a} = a_x \hat{i} + a_y \hat{j} + a_z \hat{k}$ $ \mathbf{a} = a = \sqrt{a_x^2 + a_y^2 + a_z^2}$ $ \hat{i} = 1$	
1.2 Components	$a_x = a \cos \theta$ $a_y = a \sin \theta$ $a_z = a \sin \phi$ $\theta = \arctan \frac{a_y}{a_x}$ $\phi = \arctan \frac{a_z}{a_y}$	
1.3 Addition / subtraction	$\mathbf{a} + \mathbf{b} = \mathbf{b} + \mathbf{a} = (a_x + b_x)\hat{i} + (a_y + b_y)\hat{j} + (a_z + b_z)\hat{k}$	
1.4 The dot product	$\mathbf{a} \cdot \mathbf{b} = ab \cos \gamma$ $\mathbf{a} \cdot \mathbf{b} = (a_x)(b_x) + (a_y)(b_y) + (a_z)(b_z)$	
1.5 The cross product	$\mathbf{a} \times \mathbf{b} = ab \sin \lambda \hat{n}$ $\mathbf{a} \times \mathbf{b} = ((a_y)(b_z) - (a_z)(b_y))\hat{i} + ((a_z)(b_x) - (a_x)(b_z))\hat{j} + ((a_x)(b_y) - (a_y)(b_x))\hat{k}$ $\mathbf{a} \times \mathbf{b} = \begin{pmatrix} a_x & a_y & a_z \\ b_x & b_y & b_z \end{pmatrix} \hat{i} + \begin{pmatrix} a_x & a_y & a_z \\ b_x & b_y & b_z \end{pmatrix} \hat{j} + \begin{pmatrix} a_x & a_y & a_z \\ b_x & b_y & b_z \end{pmatrix} \hat{k}$	

Why Vectors?



The components of a vector

The components of a vector

A pinch of trigonometry

Which way is up?

Unit vector notation

Worked example 1 (Ch 3 problem 1)

What are (a) the x component and (b) the y component of a vector in the xy plane if its direction is 250° counterclockwise from the positive direction of the x axis and its magnitude is 7.3 m?

Worked example 2 (Ch 3 problem 7)

Consider two displacements, one of magnitude 3 m and another of magnitude 4 m. Show how the displacement vectors may be combined to get a resultant displacement of magnitude (a) 7 m, (b) 1 m, and (c) 5 m.

Adding vectors

Worked example 3

Two vectors are given:

What is $\underline{a} + \underline{b}$?

What is $\underline{a} - \underline{b}$?

What is the magnitude of $(\underline{a} + \underline{b})$?

What is the angle of \underline{a} wrt the positive \hat{i} direction?

What is the angle between \underline{a} and \underline{b} ?

The dot product

Worked Example 4 (Ch 3 problem 39)

Vector \underline{a} has a magnitude of 6.00 units, vector \underline{b} has a magnitude of 7.00 units, and $\underline{a} \cdot \underline{b}$ has a value of 14.0. What is the angle between the directions of \underline{a} and \underline{b} ?

The cross product : spanner example

The cross product : graphically

The cross product : Lily's cartoon matrices

Recap soh-cah-toa

Recap unit vector notation, components

Recap vector multiplication

Problem solving tools

Problem 1: What makes sense?

13 Which of the following are correct (meaningful) vector expressions? What is wrong with any incorrect expression?

(a) $\vec{A} \cdot (\vec{B} \cdot \vec{C})$

(b) $\vec{A} \times (\vec{B} \cdot \vec{C})$

(c) $\vec{A} \cdot (\vec{B} \times \vec{C})$

(d) $\vec{A} \times (\vec{B} \times \vec{C})$

(e) $\vec{A} + (\vec{B} \cdot \vec{C})$

(f) $\vec{A} + (\vec{B} \times \vec{C})$

(g) $5 + \vec{A}$

(h) $5 + (\vec{B} \cdot \vec{C})$

(i) $5 + (\vec{B} \times \vec{C})$

(j) $(\vec{A} \cdot \vec{B}) + (\vec{B} \times \vec{C})$

Problem 2: The Dreaded Cube

•••32 In Fig. 3-31, a cube of edge length a sits with one corner at the origin of an xyz coordinate system. A *body diagonal* is a line that extends from one corner to another through the center. In unit-vector notation, what is the body diagonal that extends from the corner at (a) coordinates $(0, 0, 0)$, (b) coordinates $(a, 0, 0)$, (c) coordinates $(0, a, 0)$, and (d) coordinates $(a, a, 0)$? (e) Determine the angles that the body diagonals make with the adjacent edges. (f) Determine the length of the body diagonals in terms of a .

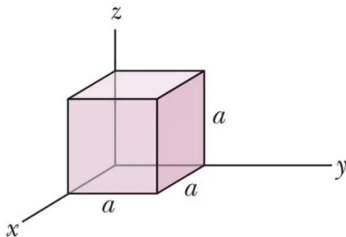
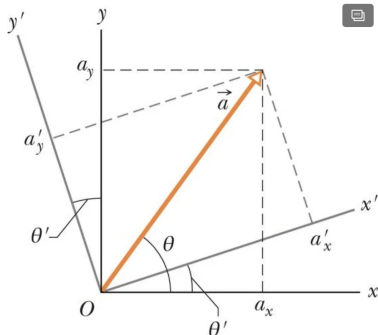


Figure 3-31 Problem 32.

Problem 3: Messing with the coordinates

••31 In Fig. 3-30, a vector \vec{a} with a magnitude of 17.0 m is directed at angle $\theta = 56.0^\circ$ counterclockwise from the $+x$ axis. What are the components (a) a_x and (b) a_y of the vector? A second coordinate system is inclined by angle $\theta' = 18.0^\circ$ with respect to the first. What are the components (c) a'_x and (d) a'_y in this primed coordinate system?



Problem 4: The 'Furious Product'

78 What is the magnitude of $\vec{a} \times (\vec{b} \times \vec{a})$ if $a = 3.90$, $b = 2.70$, and the angle between the two vectors is 63.0° ?