## PHY 116 From Newton to Einstein Coursework Sheet 1: Vectors

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*Questions 2 to 9 are taken from Young and Freedmen See also* http://ph.qmul.ac.uk/intranet/undergraduates/module?id=9

You will need the expressions,

$$\mathbf{u} \cdot \mathbf{v} = u_x v_x + u_y v_y + u_z v_z$$
$$\mathbf{u} \times \mathbf{v} = \left(u_y v_z - u_z v_y, u_z v_x - u_x v_z, u_x v_y - u_y v_x\right)$$

A1) Which of the following are vectors and which are scalars?:

- (i) Temperature, pressure, wind speed, force, velocity, position, acceleration? [7]
- (ii)  $u, \mathbf{u}, u_x, 1+2+3, (1+2+3), (1, 2, 3), \mathbf{i}+2\mathbf{j}+3\mathbf{k}, |\mathbf{i}+2\mathbf{j}+3\mathbf{k}|, \vec{u}$ ? [9]
- A2) Compute the *x* and *y*-components of the vectors  $\vec{A}$ ,  $\vec{B}$  and  $\vec{C}$



- A3) A rocket fires two engines simultaneously. One produces a thrust of 725N directly forward while the other gives a 513 N thrust at 32.4° above the forward direction. Find the magnitude and direction (relative to the forward direction) of the resultant force which these engines exert on the rocket. [4]
- A4) Find the magnitude and direction of the vectors represented by the following pairs of components:
  - a)  $A_x = -8.60 \text{ cm}, A_y = 5.20 \text{ cm};$
  - b)  $A_x = -9.70 \text{ m}, A_y = -2.45 \text{ m};$
  - c)  $A_x = 7.75$  km,  $A_y = -2.70$  km.

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[3]

- A5) Vector  $\vec{A}$  has components  $A_x = 1.30$  cm,  $A_y = 2.25$  cm; vector  $\vec{B}$  has components  $B_x = 4.10$  cm,  $B_y = -3.75$  cm. Find
  - a) the components of the vector sum  $\vec{A} + \vec{B}$ ;
  - b) the magnitude and direction of  $\vec{A} + \vec{B}$ ;
  - c) the components of the vector difference  $\vec{A} \vec{B}$ ;
  - d) the magnitude and direction of  $\vec{A} \vec{B}$ . [4]

## A6) Find the angle between each of the following pairs of vectors:

- a)  $\vec{A} = -2.00\hat{i} + 6.00\hat{j}$  and  $\vec{B} = 2.00\hat{i} 3.00\hat{j}$
- b)  $\vec{A} = 3.00\hat{i} + 5.00\hat{j}$  and  $\vec{B} = 10.00\hat{i} + 6.00\hat{j}$
- c)  $\vec{A} = -4.00\hat{i} + 2.00\hat{j}$  and  $\vec{B} = 7.00\hat{i} + 14.00\hat{j}$  [3]
- A7) Find the vector product  $\vec{A} \times \vec{B}$  (expressed in unit vectors) where  $\vec{A} = 4.00\hat{i} + 3.00\hat{j}$  and  $\vec{B} = 5.00\hat{i} - 2.00\hat{j}$ . What is the magnitude of the vector product? [2]
- A8) Two vectors  $\vec{A}$  and  $\vec{B}$  have magnitude A = 3.00 and B = 3.00. Their vector product is  $\vec{A} \times \vec{B} = -5.00\hat{k} + 2.00\hat{i}$ . What is the angle between  $\vec{A}$  and  $\vec{B}$ ? [1]
- B9) You are given vectors  $\vec{A} = 5.00\hat{i} 6.50\hat{j}$  and  $\vec{B} = -3.50\hat{i} + 7.00\hat{j}$ . A third vector  $\vec{C}$  lies in the *xy*-plane. Vector  $\vec{C}$  is perpendicular to vector  $\vec{A}$ , and the scalar product of  $\vec{C}$  with  $\vec{B}$  is 15.0. From this information, find the components of vector  $\vec{C}$ . [3]
- *Note:* The question number start with A or B to denote the level of difficulty. It relates to the structure of the written examinations which have a Part A and a Part B.