1. REVIEW QUESTIONS

1. Is it possible to define everything in electromagnetics without the use of vectors? Explain.

2. Why do we use vectors? What are the advantages in doing so?

3. Give a concise description of scalars and vectors. From your experience so far, which physical quantities can you identify as vectors and as scalars?

4. Two vectors are identical if:

(a) The two vectors have the same direction in space.

(b) They have the same magnitude.

(c) They are parallel to each other.

(d) They have the same magnitude and direction.

5. Two points are given in Cartesian coordinates, $P1(x1, y1, z1)$ and $P2(x2, y2, z2)$. Show that the vector from $P1$ to $P2$ is the negative of the vector from $P2$ to $P1$.

6. The unit vector (mark all that apply):

(a) Has magnitude 1 and is a scalar.

(b) Has magnitude 1 and is a vector.

(c) As in **(b)** but also must be in the direction of a given vector.

7. The unit vector is a true vector: the only unique thing about it is its magnitude *T/F*.

8. Is the unit of a vector quantity an integral part of the vector? Explain.

9. If two vectors have identical unit vectors:

(a) The two vectors are identical.

(b) The two vectors are parallel but not necessarily of the same magnitudes.

(c) The two vectors are parallel but can point in opposite directions.

10. Summation of vectors is:

(a) Associative and commutative

(b) Associative, commutative, and distributive.

(c) Associative and distributive.

11. The sum of two vectors can result in a third vector with magnitude smaller than either of the two vectors *T/F*. Give an example to justify your answer.

12. The subtraction of one vector from another can result in a third vector with magnitude larger than either of the two vectors *T/F*. Show an example.

13. Vector scaling refers to the change in magnitude of a vector but scaling cannot change the direction (other than flipping) *T/F*.

14. Vector scaling is commutative, and associative but not distributive *T/F*.

15. A scaled vector is always parallel to the original vector *T/F*.

16. Define the scalar product. What does it represent? Identify some simple uses of the scalar product.

17. A scalar product is any product of two vectors that produces a scalar result *T/F*. Explain.

18. Is the scalar product a "law" or is it merely a convenient notation? Explain.

19. Since $\mathbf{A} \cdot \mathbf{B} = \mathbf{B} \cdot \mathbf{A}$, is there any physical difference between the two products shown? If so, what is the difference? If not, why not?

20. Define the vector product. What does it represent? Identify some simple uses of the scalar product.

21. Is the vector product a "law" or is it merely a convenient notation? Explain.

22. Which of the following statements are correct?

(a) The vector product of two perpendicular vectors is zero.

(b) The scalar product of two perpendicular vectors is zero.

(c) The vector product of two scaled vectors is the same as the vector product of the nonscaled vectors for any two vectors.

23. Two vectors are parallel to each other if (mark correct answer):

(a) They have identical unit vectors.

(b) Their vector product is zero.

(c) Their scalar product is zero.

24. Two vectors are perpendicular to each other if:

(a) Their vector product is zero.

(b) Their unit vectors are identical.

(c) Their scalar product is zero.

25. What is a triple product? Define the legitimate vector triple products.

26. Define the legitimate scalar triple products.

27. What is the physical meaning of the scalar triple product? Give examples.

28. What is the physical meaning of the vector triple product? Give examples.

29. Multiple vector and scalar products are possible as long as the intermediate products are properly defined *T/F*.

30. Which of the following vector products yields zero and why? **A** and **B** are general vectors; $\mathbf{C} = \mathbf{A} \times \mathbf{B}$.

(a) $\mathbf{A} \times (\mathbf{B} \times (\mathbf{A} \times \mathbf{B}))$ **(b)** $\mathbf{A} \times (\mathbf{B} \times \mathbf{A}) \times \mathbf{B}$

(c) $(\mathbf{A} \times \mathbf{B}) \times (\mathbf{A} \times \mathbf{B})$ **(d)** $((\mathbf{A} \times \mathbf{B}) \times \mathbf{A}) \times \mathbf{B}$

(e) $\mathbf{A} \times (\mathbf{B} \times \mathbf{C})$ **(f)** $\mathbf{A} \times (-\mathbf{C}) \times \mathbf{B}$

(g) $\mathbf{C} \times \mathbf{C}$ **(h)** $(\mathbf{C} \times \mathbf{A}) \times \mathbf{B}$

31. Which of the following products are properly defined? (a, b, c are scalars, **A**,**B**,**C** are vectors)

(a) $a \cdot b$ **(b)** $a \cdot \mathbf{B}$

(c) $\mathbf{B} \cdot \mathbf{C} \cdot \mathbf{A}$ **(d)** $(\mathbf{A} \times \mathbf{B}) \cdot \mathbf{A}$

(e) $a(\mathbf{B} \cdot \mathbf{C})$ **(f)** $(a\mathbf{B} \times c\mathbf{A})$

32. Which of the products below are meaningless and why?

(a) $\mathbf{A} \cdot (\mathbf{A} \cdot \mathbf{B})$ **(b)** $(ab) \times \mathbf{A}$

(c) $a \times (\mathbf{A} \times \mathbf{A})$ **(d)** $\mathbf{A} \cdot (\mathbf{A} \times \mathbf{A})$

(e) $a \times (a \times \mathbf{B})$ **(f)** $(\mathbf{A} \times \mathbf{B})(a \times b) \cdot \mathbf{A}$

33. Which of the following products are meaningful? **A**,**B**,**C** are vectors; g is a scalar.

(a) $\mathbf{A} \cdot (\mathbf{A} \times (\mathbf{B} \times \mathbf{C}))$ **(b)** $g\mathbf{A} \cdot (\mathbf{A} \times \mathbf{B})$

(c) $(\mathbf{A} \times \mathbf{B}) \cdot (\mathbf{A} \times \mathbf{B})$ **(d)** $(\mathbf{A} \cdot \mathbf{B}) \times (\mathbf{A} \times \mathbf{B})$

(e) $(\mathbf{A} \cdot \mathbf{B}) \cdot (\mathbf{A} \times \mathbf{B})$ **(f)** $\mathbf{A} \cdot (\mathbf{A} \times (\mathbf{A} \times \mathbf{B}))$

(g) $\mathbf{A} \cdot (\mathbf{A} \times (\mathbf{A} \times \mathbf{A}))$

34. State succinctly the idea of a field? Can you define some fields from everyday observations?

35. What distinguishes a vector field from a scalar field?

36. Two vector fields are subject to any and all vector operations. The result may be:

(a) Only a scalar field.

(b) Only a vector field.

(c) A scalar or vector field.

(d) A scalar vector, or null field.

(e) A vector field or a null field

37. Systems of coordinates may be defined in any way we wish as long as they are uniquely defined and have some utility *T/F*.

38. Can we define non-orthogonal systems of coordinates? Explain.

39. Why do we need to define more than one system of coordinates? Could we in fact do everything in Cartesian coordinates? Explain.

40. Give the elements of surface and volume for a cube in Cartesian coordinates.

41. The element of length is a vector. What are its magnitude and unit vector?

42. Why are the elements of area defined as vectors?

43. Explain why the elements of area are not components of an "area vector"?

44. Give the elements of surface and volume for a cube in cylindrical coordinates.

45. Give the elements of surface and volume for a cube in spherical coordinates.

46. Derive the transformations from Cartesian to cylindrical coordinates and vice versa:

(a) For coordinates,

(b) For components of vectors,

(c) For unit vectors.

47. Derive the transformations from Cartesian to spherical coordinates and vice versa:

(a) For coordinates,

(b) For components of vectors,

(c) For unit vectors.

48. Derive the transformations from spherical to cylindrical coordinates and vice versa:

(a) For coordinates,

(b) For components of vectors,

(c) For unit vectors.

49. Find the distance between two general points in cylindrical coordinates.

50. Find the expression for the magnitude of a vector in cylindrical coordinates.
51. Find the distance between two general points in spherical coordinates.
52. Find the expression for the magnitude of a vector in spherical coordinates.
53. Find the volume of a cube of side a in cylindrical coordinates.
54. Find the volume of a cube of side a in spherical coordinates.
55. Define the idea of a position vector.
56. How many position vectors are necessary to define a vector?
57. Two identical position vectors define a null (zero length) vector *T/F*.