St John Baptist De La Salle Catholic School, Addis Ababa

Grade 11 Physics Midterm Examination

1st Quarter

October, 2023

Notes, and use of other aids is **NOT** allowed. Read all directions carefully and **write your answers in the answer sheet**. To receive full credit, you must show all of your work.

Name:_____ Roll Number:_____ Section:___Time Allowed: **45 min**

Multiple Choice Questions

1. Which of the following passwords would be computationally secure?
   A. A three digit number B. A 40 digit alphanumeric password
   C. A one digit number D. The password 'password'
   Answer : B

2. Which of the following steps in the scientific process comes later compared to the others?
   A. Hypothesizing B. Questioning C. Analysis D. Experimentation
   Answer : C

3. Which of the following fields of physics was a topic of the Nobel Prize in Physics this year?
   A. Quantum Optics B. Astronomy C. High energy physics D. Biophysics
   Answer : A

4. Let $\vec{C} = \vec{A} + \vec{B}$. In which of the following conditions is $|\vec{C}|$ maximum?
   A. $\vec{A} \parallel \vec{B}$ B. $\vec{A} \perp \vec{B}$ C. $\vec{A} = \vec{B}$ D. None of the above
   Answer : A

5. If the vector $6\hat{i} - 4\hat{j}$ starts at the point $P = (-2, 5, -1)$, at what point does it end?
   A. (-4,1,1) B. (4,-1,1) C. (4,1,-1) D. (-4,-1,-1)
   Answer : C

6. Which of the following vectors are parallel?
   A. $9\hat{i} - 6\hat{j} - 24\hat{k}$ and $-15\hat{i} + 10\hat{j} + 40\hat{k}$ B. $\hat{i} + \hat{j}$ and $\hat{j} + \hat{k}$
   C. $2\hat{i}$ and $4\hat{k}$ D. None of the above
   Full Credit is given for those who choose **A**, but half credit is given to those who choose **D**. That is because one might assume since the vectors are in opposite directions, they are anti-parallel an not parallel.

7. Let $\vec{u} = 8\vec{i} - \vec{j} + 3\vec{k}$ and $\vec{v} = 7\vec{j} - 4\vec{k}$. Which of the following is equal to $|-9\vec{v} - 2\vec{u}|$?
   A. $\sqrt{2893}$ B. $\sqrt{4877}$ C. 26 D. 90
   Answer : B

8. If the magnitude of $|\vec{A}+\vec{B}|$ is equal to the magnitude of $|\vec{A}-\vec{B}|$, what is the angle between $\vec{A}$ and $\vec{B}$?
   A. $\frac{\pi}{6}$ B. $\frac{\pi}{4}$ C. $\frac{\pi}{3}$ D. $\frac{\pi}{2}$
   Answer : D

9. Which of the following is a vector quantity?
   A. Current Density B. Speed C. Power D. Volume
   Answer : A

10. If three vectors sum up to zero, what can we say about the vectors?
    A. The vectors must be collinear B. The vectors must be coplanar
    C. All three vectors must be equal D. All three vectors must be orthogonal to each other
    Answer : B

Workout Problems

11. Let $\vec{A} = 4\hat{i} + 3\hat{j}$, $\vec{B} = 6\hat{i} + 6\hat{j}$. If $\vec{A} \cdot \vec{B} = 40$, what is the angle between the vectors $\vec{A}$ and $\vec{B}$.

    Unfortunately, there has been an error in this question and disregarding the given dot product $\vec{A} \cdot \vec{B} = 40$ –

    $$\cos\theta = \frac{\vec{A} \cdot \vec{B}}{AB} = \frac{(4)(6) + (3)(6)}{(5)(6\sqrt{2})}$$

    If you used the given dot product instead, I will also grade it as such.

12. If $|\vec{A}| = 2$, $|\vec{B}| = 7$. Find the angle between the vectors $\vec{A}$ and $\vec{B}$ if $|\vec{A} + \vec{B}| = 9$ and $|\vec{A} - \vec{B}| = 9$. Show all your steps.

    Unfortunately, there is also an error in this question and disregard the $|\vec{A} - \vec{B}| = 9$ part - we can solve it as follows -

    $$|\vec{A} + \vec{B}|^2 = A^2 + B^2 + 2AB\cos\theta$$

    $$\cos\theta = \frac{|\vec{A} + \vec{B}|^2 - (A^2 + B^2)}{2AB}$$

13. Let $\vec{U} = 2\hat{i} + 3\hat{j} + 4\hat{k}$ and $\vec{V} = \hat{i} + 2\hat{j} + 4\hat{k}$. What is the projection of $\vec{B}$ along $\vec{A}$? What about the component of $\vec{A}$ along $\vec{B}$?

    Another unfortunate typo here - I meant projection of $\vec{V}$ along $\vec{U}$.

    $$\mathbf{proj}_{\vec{U}}^{\vec{V}} = \frac{\vec{V} \cdot \vec{U}}{U^2}\vec{U}$$

14. The scalar triple product of three vectors $\vec{a}$, $\vec{b}$, and $\vec{c}$ is defined as $(\vec{a} \times \vec{b}) \cdot \vec{c}$. Let there be three vectors $\vec{a}$, $\vec{b}$, and $\vec{c}$ with equal magnitudes, M. If the vectors $\vec{a}$ and $\vec{b}$ have a separation

angle of $\frac{\pi}{3}$, and $\vec{b} \times \vec{a}$ makes an angle of $\frac{\pi}{4}$ to $\vec{c}$, compute the scalar triple product.

$$(\vec{a} \times \vec{b}) \cdot \vec{c}$$

$$|\vec{a} \times \vec{b}||\vec{c}| \cos\theta \text{ such that } \theta \text{ is the angle between } \vec{a} \times \vec{b} \ \& \ \vec{c}$$

But, $|\vec{a} \times \vec{b}| = |\vec{a}||\vec{b}| \sin\alpha$ - such that α is the angle between $\vec{a}$ and $\vec{b}$. So,

$$|\vec{a} \times \vec{b}||\vec{c}| \cos\theta$$

$$|\vec{a}||\vec{b}| \sin\alpha |\vec{c}| \cos\theta$$

$$|\vec{a}||\vec{b}||\vec{c}| \sin\alpha \cos\theta$$

The angle between $\vec{b} \times \vec{a}$ and $\vec{c}$ is $\frac{\pi}{4}$ which makes the angle between $\frac{3\pi}{4}$. We have also mentioned that all three vectors have the same magnitude, M - so, it becomes

$$(M)(M)(M) \sin(\frac{\pi}{3}) \cos(\frac{3\pi}{4})$$

$$(M^3)(\frac{\sqrt{3}}{2})(-\frac{\sqrt{2}}{2})$$

$$-(\frac{\sqrt{6}}{4}M^3)$$

15. Find the work done against gravity to move a 15 kg baby from the point (3,4) to (8,12).(Assume $g = 9.8\hat{j}m/s^2$)

Find the displacement vector first; $\vec{r} = (8-3)\hat{i} + (12-4)\hat{j}$, which is $\vec{r} = 5\hat{i} + 8\hat{j}$. The force, however is - $\vec{F} = (15kg)9.8m/s^2\hat{j} = 147N\hat{j}$

$$W = \vec{F} \cdot \vec{r}$$

Complete the rest