Lesson 52
Problems from Quiz Game
MA104, April 14, 2006

1. Which vector below is orthogonal to $< 1, -1, 0 >$?
   (a) $\langle -5, 5, 1 \rangle$
   (b) $\langle 3/2, 3/2, 2 \rangle$
   (c) $\langle -1, 1, 0 \rangle$
   (d) none of the above
2. If $f(x, y, z) = 5\sin(4\pi xy) + e^{x^2+z^2}$ then what is $\dfrac{\partial f}{\partial x}$?
3. What is a vector equation of the line which goes through points $P(5, -2)$ and $Q(1, 4)$?
   (a) $\mathbf{r}(t) = \langle 5, -2 \rangle + t \langle 4, -6 \rangle$
   (b) $\mathbf{r}(t) = \langle 1, 4 \rangle + t \langle -4, 6 \rangle$
   (c) $\mathbf{r}(t) = \langle 5, -2 \rangle + t \langle -4, 6 \rangle$
   (d) all of the above
   (e) none of the above
4. If $\dfrac{\partial f}{\partial x}(x, y, z) = 5\cos(4\pi xy)\ (4\pi y) + e^{x^2+z^2}(2x)$, then what is f_{xz}?
5. For a particle traveling the path $\mathbf{r}(t) = \langle 5t^2 - \sin(3t), 45 + 8t - e^{2t} \rangle$, what is its speed at $t = 0$?
6. For a particle traveling the path $\mathbf{r}(t) = \langle 5t^2 - \sin(3t), 45 + 8t - e^{2t} \rangle$, what is its acceleration at $t = 0$?
7. For two nonzero vectors $\mathbf{a}$ and $\mathbf{b}$, what can you conclude about the relationship $\mathbf{a} \times \mathbf{b}$ and $\mathbf{a}$?
8. At the point $(1, 0)$, what is the direction of the greatest rate of change of $f(x, y) = 5x^2y + 6\sin(y)$?
9. For $f(x, y) = 5x^2y + 6\sin(y)$, what is the derivative at the point $(1, 0)$ in the direction of $\mathbf{v} = 2\mathbf{i} + 5\mathbf{j}$?
10. What is the angle between $\langle 1, 3, 1 \rangle$ and $\langle 5, -1, 2 \rangle$?

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1. (b) $\langle 3/2, 3/2, 2\rangle$ because the dot product of this vector with the given on is equal to zero.

2. $\dfrac{\partial f}{\partial x} = 5\cos(4\pi xy)\ (4\pi y) + e^{x^2+z^2}(2x)$

3. *This question was phrased incorrectly during class...the equations I listed were all* vector *equations, not* parametric equations *as the question originally read. I meant to ask for vector equations.*
   Answer: (d) all of the above (Try plotting them with `ParametricPlot[]` or by hand if you don't believe me.)

4. $f_{xz}(x, y, z) = e^{x^2+z^2}(2x)(2z)$.

5. The particle's speed is $\sqrt{45}$. (Speed is the magnitude (length) of the velocity vector and the velocity vector is the derivative of the given position vector.)

6. The particle's acceleration is $\langle 10, -4\rangle$. (Acceleration is the second derivative of position. For mathematics, "acceleration" refers to a vector quantity while a phrase such as "how fast was it accelerating" refers to the length of the acceleration vector.)

7. Answer: $\mathbf{a}$ is perpendicular to $\mathbf{a} \times \mathbf{b}$. (The cross product always produces a vector that is orthogonal to both $\mathbf{a}$ and $\mathbf{b}$.)

8. From point $(1, 0)$, the direction of the greatest rate of change is $\langle 0, 11\rangle$ (The gradient (∇f) indicates the direction of the greatest rate of change.)

9. Answer: $55/\sqrt{29}$ (The dot product of the gradient and the unit vector in the direction of $\mathbf{v}$ is the directional derivative.)

10. Answer: around 77.3°. (This is calculated from the definition of dot product.)