Phys 4L Diagnostic Exam (19 questions)

Participation Credit

This diagnostic is *not* graded for correctness. It is used only to help set the pace of the course. Please do not use external resources.

Section A — Basic Circuit Facts

1. If the resistance of a resistor is doubled while the voltage across it is held constant, the current through it:
    A. Doubles
    B. Halves
    C. Stays the same
    D. Goes to zero
2. A resistor is connected to a fixed voltage source. Which change will decrease the power dissipated in the resistor?
    A. Increasing the resistance
    B. Decreasing the resistance
    C. Increasing the voltage
    D. None of the above
3. Two resistors are connected in series. Which quantity is the same through both?
    A. Voltage
    B. Current
    C. Power
    D. Resistance
4. Two resistors are connected in parallel. Which quantity is the same across both?
    A. Current
    B. Power
    C. Voltage
    D. Resistance

Section B — Differential Equations

5. Which of the following is a first-order differential equation?
    A. $\frac{d^2x}{dt^2} + x = 0$
    B. $\frac{dx}{dt} = -kx$
    C. $x^2 + t = 0$
    D. $\frac{d^2x}{dt^2} = \sin(t)$

6. The solution to the differential equation below has which qualitative behavior?

$$\frac{dx}{dt} = -kx \quad (k > 0)$$

   A. Linear decay
   B. Exponential decay
   C. Oscillatory motion
   D. Constant value

7. How many initial conditions are required to uniquely solve a first-order ODE?
   A. One
   B. Two
   C. Three
   D. None

8. The equation below describes motion that is:

$$\frac{d^2x}{dt^2} + \omega^2 x = 0$$

   A. Exponentially growing
   B. Exponentially decaying
   C. Oscillatory
   D. Constant

9. How many initial conditions are required to uniquely solve a second-order ODE?
   A. One
   B. Two
   C. Three
   D. Infinitely many

Section C — Partial Derivatives

10. Let

$$f(x, y, z) = x^2y + xyz + z^2$$

   What is ∂f/∂x?
   A. 2xy + yz
   B. 2xy + z
   C. xy + yz
   D. 2x + y

11. For the same function, what is ∂f/∂y?
   A. $x^2 + xz$
   B. $2xy + z^2$
   C. $x^2 + yz$
   D. x + z

Section D — Linear Algebra Fundamentals

12. Which of the following is a linear combination of vectors **u** and **v**?
    A. **u** × **v**
    B. **u** · **v**
    C. 3**u** − 2**v**
    D. |**u**| + |**v**|
13. Two vectors form a basis for a 2-dimensional vector space if they are:
    A. Orthogonal
    B. Linearly independent
    C. Parallel
    D. Normalized
14. If A is a 2×3 matrix and B is a 3×4 matrix, the product AB is:
    A. 2×3
    B. 3×4
    C. 2×4
    D. Not defined
15. Matrix multiplication is generally:
    A. Commutative
    B. Associative
    C. Both
    D. Neither
16. The identity matrix I satisfies:
    A. IA = 0
    B. IA = A
    C. IA = A^T
    D. IA = A^{-1}

Let

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}, \quad B = \begin{bmatrix} 0 & 1 \\ 1 & 2 \end{bmatrix}$$

17. What is AB?
    A. $\begin{bmatrix} 2 & 5 \\ 4 & 11 \end{bmatrix}$
    B. $\begin{bmatrix} 2 & 5 \\ 6 & 11 \end{bmatrix}$
    C. $\begin{bmatrix} 1 & 4 \\ 3 & 10 \end{bmatrix}$
    D. $\begin{bmatrix} 0 & 1 \\ 1 & 2 \end{bmatrix}$
18. What is BA?
    A. $\begin{bmatrix} 3 & 4 \\ 7 & 10 \end{bmatrix}$

B. $\begin{bmatrix} 3 & 4 \\ 5 & 8 \end{bmatrix}$

C. $\begin{bmatrix} 2 & 5 \\ 4 & 11 \end{bmatrix}$

D. $\begin{bmatrix} 5 & 2 \\ 11 & 4 \end{bmatrix}$

19. Let

$$M = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}, \ \boldsymbol{v} = \begin{bmatrix} x \\ y \end{bmatrix}$$

What is M**v**?

A. $\begin{bmatrix} x + 2y \\ 3x + 4y \end{bmatrix}$

B. $\begin{bmatrix} x + y \\ 3x + y \end{bmatrix}$

C. $\begin{bmatrix} 2x + y \\ 4x + y \end{bmatrix}$

D. $\begin{bmatrix} 4x \\ 6y \end{bmatrix}$