Circuits & Waves Review

1. A 9.0 V battery is connected in series with two resistors, $R_1 = 3.0\ \Omega$and $R_2 = 6.0\ \Omega$.
   Determine:
   - (a) total resistance
   - (b) total current
   - (c) voltage drop across each resistor

2. A 12.0 V battery is connected to two resistors in parallel, $R_1 = 4.0\ \Omega$and $R_2 = 12.0\ \Omega$.
   Determine:
   - (a) equivalent resistance
   - (b) total current
   - (c) current through each resistor

3. Two resistors are connected in series. The total current in the circuit is 2.0 A. If the voltage drops across the resistors are 4.0 V and 8.0 V, determine:
   - (a) the resistance of each resistor
   - (b) the total voltage of the source

4. A 6.0 V battery is connected to two resistors in parallel. The currents through the resistors are 0.50 A and 1.0 A.
   Determine:
   - (a) the resistance of each resistor
   - (b) the total resistance of the circuit

5. A 12.0 V battery is connected to:
   - a 5.0 Ω resistor in series with
   - a parallel combination of 10.0 Ω and 20.0 Ω

   Determine:
   (a) equivalent resistance of the parallel section
   (b) total resistance
   (c) total current
   (d) current through each resistor

6. A circuit consists of two branches in parallel:
   - Branch A: a single 8.0 Ω resistor
   - Branch B: two resistors in series, 3.0 Ω and 5.0 Ω

   The circuit is connected to a 16.0 V battery. Determine:
   (a) total resistance
   (b) current in each branch
   (c) current through each resistor

7. A 9.0 V battery is connected to a circuit where:
   - one branch has a 6.0 Ω resistor
   - the other branch has two 3.0 Ω resistors in series

   Determine:
   (a) total resistance
   (b) total current
   (c) current through each resistor

8. A combination circuit has a total resistance of 4.0 Ω and is connected to a 12.0 V battery.
   Determine:
   (a) the total current supplied by the battery
   (b) the voltage across the parallel section of the circuit

9. A real battery has an emf of 12.0 V and an internal resistance of 1.5 Ω. It is connected to a single external resistor of 6.0 Ω.
   Determine:
   (a) total resistance
   (b) current
   (c) terminal voltage

10. A real battery with emf 18.0 V and internal resistance 1.0 Ω is connected to two external resistors in series:
    $R_1 = 4.0\ \Omega$, $R_2 = 5.0\ \Omega$.
    Determine:
    (a) total current
    (b) terminal voltage
    (c) voltage drop across each external resistor

11. A battery with emf 24.0 V supplies current to two resistors in parallel: 6.0 Ω and 12.0 Ω. The terminal voltage is measured to be 18.0 V.
    Determine:
    (a) total current supplied
    (b) the internal resistance of the battery

12. A battery has an emf of 15.0 V and internal resistance 2.0 Ω. It is connected to two resistors in parallel: 4.0 Ω and 12.0 Ω.
    Determine:
    (a) equivalent resistance of the external circuit
    (b) total current
    (c) power dissipated in the internal resistance

13. Classify each as:
    - pulse or continuous
    - transverse or longitudinal
    - mechanical or electromagnetic

    (a) A single ripple moving across a pond
    (b) A sound wave from a speaker
    (c) Light traveling through glass

14. A wave has a frequency of 5.0 Hz. Determine:
    (a) the period
    (b) how many cycles occur in 12 seconds

15. A wave travels at 3.0 m/s and has a wavelength of 0.60 m. Determine:
    (a) frequency
    (b) period

16. Ocean waves pass a buoy at a rate of 10 crests in 20 s. The distance between crests is 4.0 m. Determine:
    (a) frequency
    (b) wave speed

17. A mass oscillates with an amplitude of 4.0 cm and a period of 2.0 s. Assume it passes through equilibrium moving upward at $t = 0$.
    (a) Write the displacement function
    (b) Determine the first time the mass reaches maximum height

18. A spring oscillates with a frequency of 3.0 Hz and amplitude 2.0 cm. Determine:
    (a) the period
    (b) the displacement function
    (c) how many times it reaches maximum displacement in 2.0 s

19. A wave has an amplitude of 5.0 cm and wavelength 1.0 m. Assume the wave passes through equilibrium at $x = 0$and is increasing.
    (a) Write the spatial wave equation
    (b) Find the position of the first crest

20. A transverse wave travels along a rope with wavelength 0.80 m. Determine:
    (a) the distance between consecutive zero crossings
    (b) the distance from equilibrium to the first crest

21. A siren emits a frequency of 600 Hz. It moves toward a stationary observer at 20 m/s. Assume the speed of sound is 340 m/s.
    (a) Determine the observed frequency
    (b) Explain why the frequency increases

22. Light travels from air into water at an angle of incidence of 40°.
    The refractive index of water is 1.33.
    (a) Determine the angle of refraction
    (b) Explain why the ray bends toward the normal

23. A wave has a frequency of 2.0 Hz and wavelength 1.5 m.
    (a) Determine the wave speed
    (b) Sketch one full wavelength and label amplitude and wavelength