Kinematics

Solution 1:

- Initial velocity (v_1) = 0 m/s, acceleration (a) = 2.5 m/s^2, time (t) = 10 s.
- Use the equation: $d = v_1t + (1/2)at^2$.
- $d = (0)(10) + (1/2)(2.5)(10^2) = 125$ m.

Solution 2:

- (a) Maximum height:
  - Initial velocity (v_1) = 20 m/s, final velocity (v_2) = 0 m/s, acceleration (a) = -9.8 m/s^2.
  - Use the equation: $v_2^2 = v_1^2 + 2ad$.
  - $0 = (20)^2 + 2(-9.8)(d)$.
  - $d = 20^2 / (2 \times 9.8) = 20.4$ m.
- (b) Total time:
  - Time to reach max height = $v_1 / g = 20 / 9.8 = 2.04$ s.
  - Total time = $2 \times 2.04 = 4.08$ s.

Solution 3:

- Distance (d) = 100 m, time (t) = 10 s.
- Average speed = $d / t = 100 / 10 = 10$ m/s.

2. Dynamics

Solution 1:

- Mass (m) = 10 kg, force (F) = 50 N, coefficient of friction (μ) = 0.2.
- (a) Frictional force = μ × normal force = μ × (m × g) = $0.2 \times (10 \times 9.8) = 19.6$ N.
- (b) Net force = applied force - friction = 50 - 19.6 = 30.4 N.
- (c) Acceleration = net force / mass = 30.4 / 10 = 3.04 m/s^2.

Solution 2:

- (a) At rest:
  - Tension = weight = m × g = $5 \times 9.8 = 49$ N.
- (b) Accelerating upwards:
  - Tension = $m(g + a) = 5(9.8 + 2) = 59$ N.

3. Energy and Work

Solution 1:

- (a) Gravitational potential energy = mgh = 2 × 9.8 × 5 = 98 J.
- (b) Work done = mgh = 98 J (same as GPE since height is the same).

Solution 2:

- m = 500 kg, h = 20 m, g = 9.8 m/s^2.
- Total energy = potential energy = mgh = 500 × 9.8 × 20 = 98,000 J.
- At the bottom, all energy converts to kinetic energy:
  - KE = $(1/2)mv_2^2$.
  - 98,000 = $(1/2)(500)v_2^2$.
  - v_2^2 = 98,000 / 250 = 392.
  - $v_2 = \sqrt{392} \approx 19.8$ m/s.

4. Waves and Sound

Solution 1:

- Frequency (f) = 500 Hz, wavelength (λ) = 0.7 m.
- Wave speed = f × λ = 500 × 0.7 = 350 m/s.

Solution 2:

- Speed = 340 m/s, frequency = 1700 Hz.
- Wavelength = speed / frequency = 340 / 1700 = 0.2 m.

Solution 3:

- The Doppler Effect is the change in frequency or wavelength of a wave relative to an observer moving relative to the source. Example: Ambulance siren pitch changes as it moves towards or away from an observer.

5. Electricity and Magnetism

Solution 1:

- Resistance (R) = 6 Ω, Voltage (V) = 12 V.
- (a) Current = V / R = 12 / 6 = 2 A.
- (b) Power = V × I = 12 × 2 = 24 W.

Solution 2:

- Series total resistance = R1 + R2 + R3 = 4 + 6 + 8 = 18 Ω.

Solution 3:

- Parallel total resistance:
    - $1/R = 1/R1 + 1/R2 + 1/R3 = 1/4 + 1/6 + 1/8$.
    - Common denominator = 24.
    - $1/R = 6/24 + 4/24 + 3/24 = 13/24$.
    - $R = 24/13 \approx 1.85\ \Omega$.

6. Forces in Two Dimensions

Solution 1:

- Force (F) = 15 N, angle (θ) = 30°.
- Horizontal component = $F \times \cos(\theta) = 15 \times \cos(30°) \approx 12.99$ N.
- Vertical component = $F \times \sin(\theta) = 15 \times \sin(30°) = 7.5$ N.

Solution 2:

- Airspeed = 200 km/h, wind speed = 50 km/h.
- Resultant velocity = $\sqrt{(\text{airspeed}^2 + \text{wind speed}^2)}$.
- Resultant velocity = $\sqrt{(200^2 + 50^2)} = \sqrt{(40000 + 2500)} = \sqrt{42500} \approx 206$ km/h.

7. Circular Motion and Gravitation

Solution 1:

- Gravitational field strength = 6.5 N/kg, mass = 2000 kg.
- Gravitational force = field strength × mass = 6.5 × 2000 = 13,000 N.

Solution 2:

- Radius (r) = 50 m, speed (v) = 15 m/s, mass (m) = 1200 kg.
- Centripetal force = $(mv^2) / r = (1200 \times 15^2) / 50 = (1200 \times 225) / 50 = 5400$ N.