Unit 1: Kinematics

1. Create position, velocity and acceleration time graphs for the box below

2. You walk 850 m [N], 1250m [S] and then 205m [S] in 55 minutes. Calculate your average speed and velocity.
   \([0.70 \text{ m/s}, 0.18 \text{ m/s}[S]]\)

3. A car rolling down the hill has an initial velocity of 5 m/s [E]. 10 seconds later it has a velocity of 45 m/s [E]. How far did the car travel in that time? \([200 \text{ m}[E]\])

4. You travel 55 km [E 30° N], and then 75 km [W 20° N].
   a. What is your total displacement? \([58 \text{ km}[W67°N]\])
   b. If it took you 1.2 hours, what is your average speed \([108 \text{ km/h}\])
   c. If it took you 1.2 hours, what is your average velocity \([48 \text{ km/h}[W67°N]\])

5. You kick a football at 20° from the horizontal with an initial velocity of 50 m/s.
   a. How long is the ball in the air \([3.5 \text{ s}\])
   b. What is the max height of the ball \([15 \text{ m}\])
   c. What is the range of the ball \([160 \text{ m}\])
Unit 2: Dynamics

1. Draw an FBD of the box sliding down the ramp to the right
2. Alice (40 kg) and Bob (60 kg) are standing next to each other on skates. If Bob pushes Alice with a force of 200 N [E],
   a. Draw FBD’s of Alice and Bob, including the magnitude of all forces
   b. Calculate the acceleration of Bob and Alice [5.0 m/s², 3.3 m/s²]
3. An elevator with people in it has a mass of 2000 kg
   a. Calculate the tension in the cable supporting the elevator as it is moving downwards at a constant velocity of 8.0 m/s [down]. Include a FBD [20 kN]
   b. If the elevator stops in 2.5 seconds, calculate the force of tension in the cable. Include a FBD [13 kN]
4. Mass 1 to the right has a mass of 100 g and mass 2 is 15 g.
   a. Calculate the acceleration of the boxes and force in the rope if you neglect friction. [1.28 m/s², 0.13 N]
   b. Calculate the acceleration of the boxes and force in the rope if the force of kinetic friction between m1 and the surface is 0.24. [0 m/s², 0.15 N]
5. Box A to the right has a mass of 50 kg and box B has a mass of 85 kg. If you apply a force of 20 N to box A,
   a. Calculate the acceleration of the boxes (neglecting friction). [0.15 m/s²]
   b. Calculate the force box A applies on box B and the force box B applies on box A. [13 N, 13 N]
   c. If the coefficient of static friction is 0.55, calculate the force required to move the boxes. [730 N]
   d. Describe 3 ways you could decrease this force
Unit 3: Energy

1. How much work do you do when pulling a box for 25m.
   a. If you pull the box with a 500N horizontal force [12.5 kJ]
   b. If you pull the box with a 500N force 20° from the horizontal [11.7 kJ]
   c. If there is a constant friction force of 300N, how much work does the friction apply to the box [-7.5 kJ]

2. Create an energy transformation diagram for a car burning gas to accelerate down the road

3. At the bottom of a 5.0 kg pendulum's swing, it is travelling at 15m/s. How high will the pendulum swing? [12 m]

4. A light bulb uses 3.0 MJ of electrical energy in a day.
   a. How much electrical power does the bulb use [35W]
   b. If it is 5% efficient, how much energy is transformed into useful energy [150kJ]
   c. How much energy is lost, which type of energy are most of the losses due to [2.9mJ]

5. How much energy does it take to heat 2.4 kg of liquid ethanol from 0°C to 100°C. Use the information below:
   [2.5MJ]
   a. Melting point = -114°C
   b. Boiling point = 78°C
   c. Latent heat of fusion = 109 kJ/kg
   d. Latent heat of vaporization = 838 kJ/kg
   e. C(liquid) = 1930 J/(kg°C)
   f. C(gas) = 1530 J/(kg°C)
Unit 4: Waves & Sound

1. Sketch a transverse and longitudinal wave. Label all characteristics (wavelength, amplitude, peak, trough, wavelength, rarefaction, compression)

2. If a string vibrates 7000 times in 1 minute.
   a. Calculate the frequency [117 Hz]
   b. Calculate the period [0.0086 s]

3. Calculate the wavelength of a 3000 Hz sine wave travelling through air at 10°C. [0.11 m]

4. You have a bottle that is 30 cm tall with an open top. If you blow over the top of the bottle it will produce a sound.
   a. Sketch standing wave of the first 3 harmonics produced in the bottle
   b. Calculate wavelength of the fundamental (first harmonic) [1.2 m]
   c. Calculate the frequency of the first harmonic. Assume the air is at 20°C. [290 Hz]

5. A violin string is 0.45 m long. Calculate the frequency of the third harmonic if the speed of sound in the string is 6000 m/s. [20 kHz]
Unit 5: Electromagnetism

1. How much charge passes through a 2.5 µA circuit in 5 minutes? \(0.00075 \text{C or } 750 \mu \text{C}\)

2. In the circuit on the right, \(R_1 = 300 \Omega, R_2 = 300 \Omega, R_3 = 50 \Omega, R_4 = 100 \Omega, R_5 = 100 \Omega\). Assume the battery is a 120V power source.
   a. Calculate the total resistance of the circuit \(250 \Omega\)
   b. Calculate the total current coming out of the power source \(0.48A\)
   c. Calculate the current and voltage through each resistor. \(R_1 = 0.24A, 72V, R_2 = 0.24A, 72V, R_3 = 0.48A, 24V, R_4 = 24V, R_5 = 0.24A, 24V\)

3. An XBox uses 180 W of electrical power.
   a. If it is operated for 2 hours, how much energy does it use (in J and kWh)? \(1.30 \text{MJ, } 0.36 \text{kWh}\)
   b. If it is plugged into a 120V outlet, how much current does it use? \(1.5A\)
   c. If it is plugged into a 120V outlet, how much resistance does it have? \(80 \Omega\)

4. Sketch the magnetic field lines for the following magnets:

5. If the wire below is placed in a magnetic field as shown,
   a. Describe the direction of the force on the wire if there is a conventional current going into the page. \(\text{left}\)
   b. If you move the wire to the left, which direction would a current be induced? \(\text{into page}\)