Problem 1: When you drive to work on a winding road, the odometer of your car changes from 27123 km to 27134 km.

Part (a) The distance your car traveled is ________.
MultipleChoice :

1) greater than 11 km
2) less than 11 km
3) exactly 11 km

Part (b) The magnitude of your car's displacement is ________.
MultipleChoice :

1) greater than 11 km
2) exactly 11 km
3) less than 11 km

Problem 2: When you drive to work on a winding road, the odometer of your car changes from 27120 km to 27140 km in 30 minutes.

Part (a) Your car's average speed was ________.
MultipleChoice :

1) more than 40 km/h
2) less than 40 km/h
3) exactly 40 km/h

Part (b) The magnitude of your car's average velocity was ________.
MultipleChoice :

1) more than 40 km/h
2) less than 40 km/h
3) exactly 40 km/h

Problem 3: Answer the following question concerning velocity and speed.

If a particle has constant velocity, is its speed necessarily constant?
MultipleChoice :

1) no
2) yes

Problem 4: Answer the following question concerning velocity and speed.

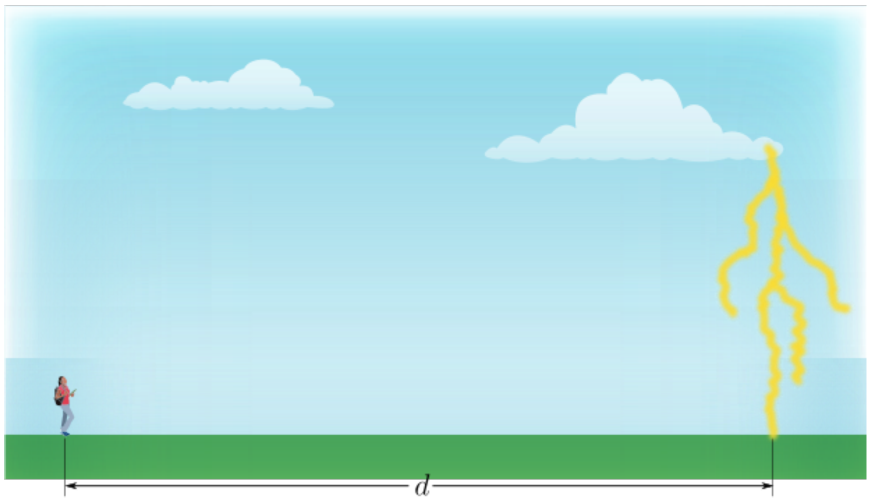
If a particle has constant speed, is its velocity necessarily constant?
MultipleChoice :

1) yes
2) no

Problem 5: In a biathlon race you first ride a bicycle at an average speed of ***19.9*** miles per hour for ***17.5*** miles, then you must run for another ***6.5*** miles.

With what average speed, in miles per hour, must you run if your average speed for the entire race is to be *12.6* mi/h?
Numeric : A numeric value is expected and not an expression.
v_2 = ____ mph

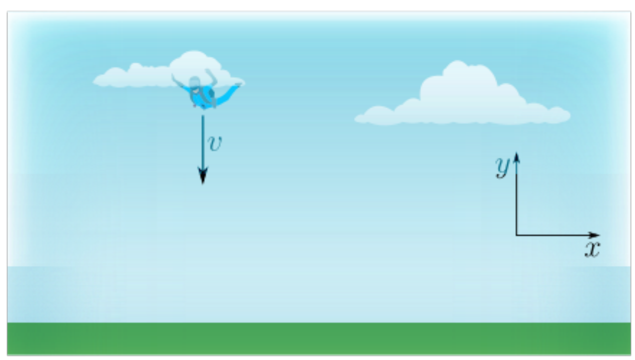
Problem 6: A student witnesses a flash of lightning, and, 9.5 s later, the student hears the associated clap of thunder.



Part (a) Sound travels at 343 m/s in the air. What distance from the student, in meters, is the lightning strike?
Numeric : A numeric value is expected and not an expression.
d = ____ m

Part (b) Light travels at 3.0×10^8 m/s in the air. How long, in seconds, did it take the light to reach the student's eyes after the lightning strike?
Numeric : A numeric value is expected and not an expression.
Δt = ____ s

Problem 7: A skydiver plunges $d_1 = 457$ m in $t_1 = 8.9$ s before opening her parachute. After the chute opens, she plunges an additional $d_2 = 721$ m in $t_2 = 106.5$ s. A coordinate system is indicated in the figure.



Part (a) Enter an expression for the skydiver's average speed, v_1, during the period before opening the chute in terms of the given quantities.
Expression :
v_1 = ____

Select from the variables below to write your expression. Note that all variables may not be required.
α, β, θ, d, d_1, d_2, g, h, i, j, m, P, t, t_1, t_2

Part (b) Enter an expression for the skydiver's average speed, v_2, during the period after opening the chute in terms of the given quantities.
Expression :
v_2 = ____

Select from the variables below to write your expression. Note that all variables may not be required.

α, β, θ, d, d_1, d_2, g, h, i, j, m, P, t, t_1, t_2

Part (c) Enter an expression for the skydiver's average speed during the entire fall, v_{avg}, in terms of the given quantities.
Expression :
v_{avg} = ____

Select from the variables below to write your expression. Note that all variables may not be required.
α, β, θ, d, d_1, d_2, g, h, i, j, m, P, t, t_1, t_2

Part (d) Calculate the skydiver's average speed, v_{avg}, in meters per second, during the entire fall.
Numeric : A numeric value is expected and not an expression.
v_{avg} = ____ m/s

Problem 8: A particle's position along the *x*-axis is described by the function

$$x(t) = A\ t + B\ t^2,$$

where *t* is in seconds, *x* is in meters, and the constants *A* and *B* are given below.

Randomized Variables
A = ***-4.6*** m/s
B = ***6.6*** m/s^2

Part (a) Enter an expression, in terms of *A*, *B*, and *t*, for the velocity of the particle as a function of time.
Expression :
$v(t)$ = ____

Select from the variables below to write your expression. Note that all variables may not be required.
α, β, π, θ, A, B, d, g, h, j, k, m, P, S, t

Part (b) At what time, in seconds, is the particle's velocity zero?
Numeric : A numeric value is expected and not an expression.
t = ____ s

Problem 9: A particle's position along the *x*-axis is described by
$x(t) = A\ t + B\ t^2$,
where *t* is in seconds, *x* is in meters, and the constants *A* and *B* are given below.

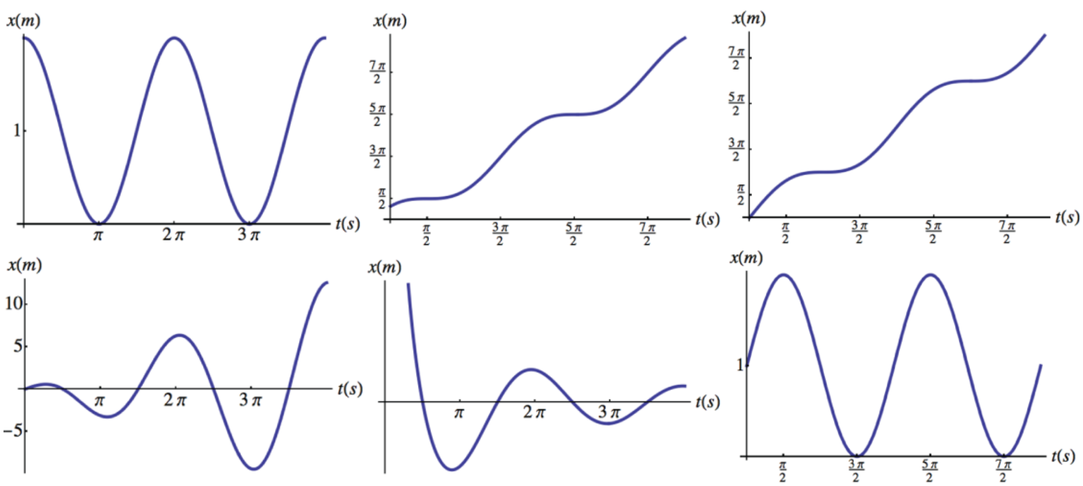
Randomized Variables
A = ***-2.5*** m/s
B = ***3.9*** m/s^2

Part (a) What is the velocity, in meters per second, of the particle at the time t_1 = 3.0 s?
Numeric : A numeric value is expected and not an expression.
$v(t)$ = ____ m/s

Part (b) What is the velocity, in meters per second, of the particle when it is at the origin (x = 0) at time $t_0 > 0$?
Numeric : A numeric value is expected and not an expression.
$v(t_0)$ = ____ m/s

Problem 10: A particle moves in one dimension according to $x(t) = A\,t + B\cos(t)$, where x is in meters and t is in seconds. You can assume that both A and B are greater then zero.

Part (a) Carefully consider the function x(t). Which of the graphs below best represents it?
SchematicChoice :



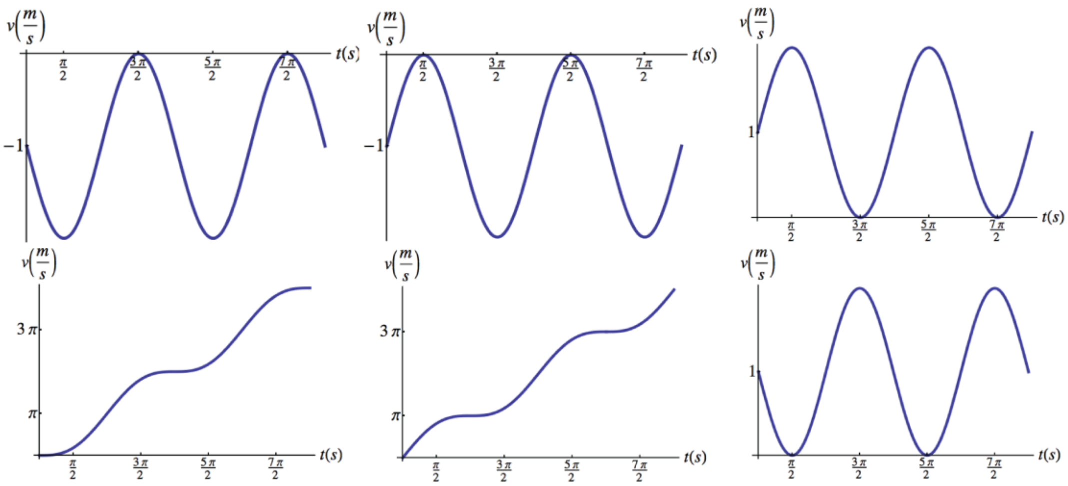
Part (b) Write an equation for the instantaneous velocity, $v(t)$.
Expression :
$v(t)$ = ____

Select from the variables below to write your expression. Note that all variables may not be required.
cos(α), cos(φ), cos(θ), cos(t), sin(α), sin(φ), sin(θ), sin(t), γ, θ, A, B, m, n, t

Part (c) When, for value of time $t \geq 0$ is the velocity equal to zero m/s? You may assume that $A = B$.
MultipleChoice :

1) For $t = \pi/2(1+3n)$, where $n \geq 0$.
2) For $t = \pi/2(1+4n)$, for all integers $n \geq 0$.
3) For $t = n\pi$, where $n \geq 0$.
4) Only at $t = \pi/2$.
5) For $t = n\pi/2$, where $n \geq 0$.
6) Only at $t = 0$.
7) For $t = \pi/2(1+2n)$, where $n \geq 0$.
8) None of these.

Part (d) Which of the options below shows a graph of the velocity of the particle as a function of time?
SchematicChoice :



Problem 11: There are two factors that contribute to the total stopping distance for a traveling vehicle, the perception-reaction distance and the braking distance. When an event occurs that requires an emergency stop, the vehicle continues to travel at its initial velocity for the perception-reaction distance while the driver reacts to the event. Once the brakes are applied, the vehicle undergoes constant acceleration as it travels the braking distance. Historically, engineers used a perception-reaction time of 0.75 second, but now they assume a perception-reaction time of 1.0 second for the average driver.

Part (a) A vehicle has an initial speed v_0. The driver has a perception-reaction time of t_{react}. When the driver begins braking, the magnitude of the vehicle's acceleration is a. Enter an expression for the total stopping distance of the vehicle.

Expression :

x_{total} = ____

Select from the variables below to write your expression. Note that all variables may not be required.

β, θ, a, d, g, h, j, k, m, n, P, S, $\mathbf{t_{react}}$, $\mathbf{v_0}$, $\mathbf{x_f}$

Part (b) A vehicle has an initial speed v_0. The driver has a perception-reaction time of t_{react}. As the vehicle is driven down the road, a tree falls onto the road a distance x_{f} in front of the vehicle. When the driver begins braking, the magnitude of the vehicle's acceleration is a. While the driver has enough time to be able to react and begin braking, the car will not stop before it hits the tree. Write an expression for the speed of the vehicle as it hits the tree.

Expression :

v_f = ____

Select from the variables below to write your expression. Note that all variables may not be required.

β, θ, a, d, g, h, j, k, m, n, P, q, $\mathbf{t_{react}}$, $\mathbf{v_0}$, $\mathbf{x_f}$

Part (c) A vehicle has an initial speed $v_0 = 34.7$ m/s when a tree falls on the roadway $x_f = 82.9$ m in front of the vehicle. The driver has a perception-reaction time of $t_{\text{react}} = 0.75$ s, and, when the driver begins braking, the magnitude of the vehicle's acceleration is $a = 6.48$ m/s^2. Calculate the speed of the vehicle, in meters per second, when it hits the tree.

Numeric : A numeric value is expected and not an expression.

v_f = ____ m/s

Part (d) A vehicle has an initial speed $v_0 = 34.7$ m/s when a tree falls on the roadway $x_f = 82.9$ m in front of the vehicle. The driver has a perception-reaction time of $t_{\text{react}} = 1.00$ s, and, when the driver begins braking, the magnitude of the vehicle's acceleration is $a = 6.48$ m/s^2. Calculate the speed of the vehicle, in meters per second, when it hits the tree.

Numeric : A numeric value is expected and not an expression.

v_f = ____ m/s

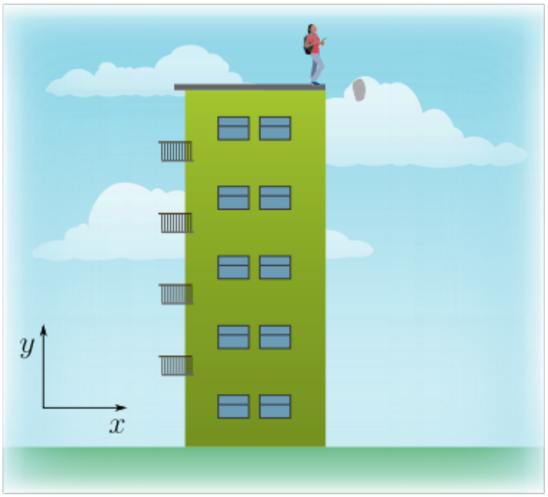
Problem 12: A particle is initially at rest at the origin at t = 0.00 s. From t = 0.00 s to t = 5.00 s its velocity changes according to $v(t)$ = (3.20 m/s^2)t. From t = 5.00 s to t = 11.00 s its velocity changes according to $v(t)$ = (16.00 m/s) - (1.50 m/s^2)(t - 5.00 s). From t = 11.00 s to t = 20.00 s its velocity does not change.

Part (a) What is the position of the particle at t = ***3.83***?
Numeric : A numeric value is expected and not an expression.
x = ____

Part (b) What is the position of the particle at t = ***7.62***?
Numeric : A numeric value is expected and not an expression.
x = ____

Part (c) What is the position of the particle at t = ***13.76***?
Numeric : A numeric value is expected and not an expression.
x = ____

Problem 13: A stone is dropped from rest from the top of a high-rise. It takes $\Delta t = 2.14$ s for it to reach the ground. Use the coordinate axes provide in the image.



Part (a) What is the initial velocity, in meters per second, of the stone?
Numeric : A numeric value is expected and not an expression.
v_i = ____ m/s

Part (b) What is the magnitude, in meters per squared second, of the acceleration?
Numeric : A numeric value is expected and not an expression.
$|a|$ = ____ m/s^2

Part (c) Enter an expression for the final velocity, v_f, of an object that has an initial velocity, v_i, and accelerates with acceleration a for a time period Δt.
Expression :
v_f = ____

Select from the variables below to write your expression. Note that all variables may not be required.
β, Δt, θ, a, d, g, h, i, j, k, L, m, n, P, v_i

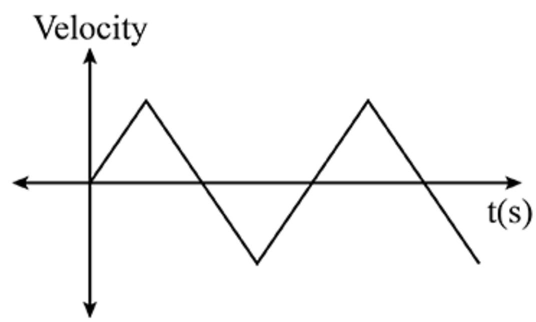
Part (d) Calculate the magnitude, in meters per second, of the final velocity of the stone.
Numeric : A numeric value is expected and not an expression.
$|v_f|$ = ____ m/s

Part (e) Enter an expression for the displacement, Δy, of an object that has an initial velocity, v_i, and accelerates with acceleration a for a time period Δt.
Expression :
Δy = ____

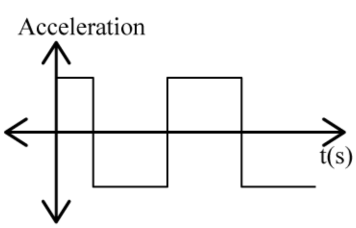
Select from the variables below to write your expression. Note that all variables may not be required.
β, Δt, θ, a, b, d, g, h, i, j, k, m, n, P, v_i

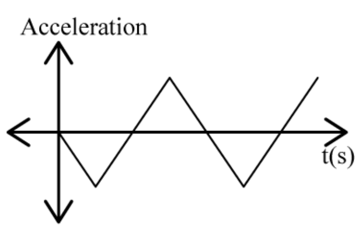
Part (f) Calculate the magnitude, in meters, of the displacement of the stone.
Numeric : A numeric value is expected and not an expression.
$|\Delta y|$ = ____ m

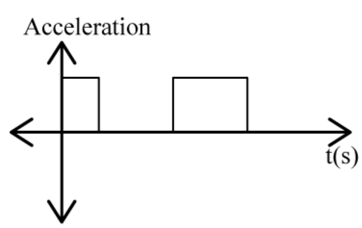
Problem 14: The velocity versus time graph for the motion of an article is shown in the figure.

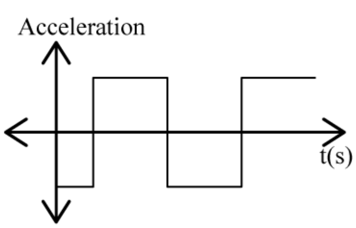


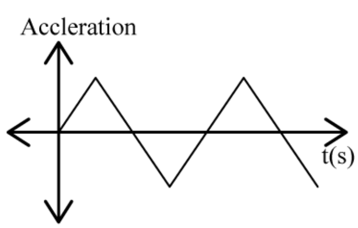
Choose the correct acceleration versus time graph for the article.
SchematicChoice :



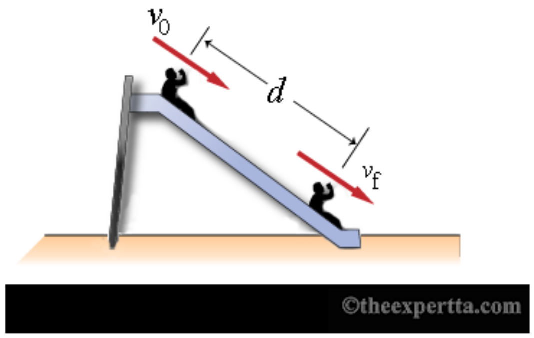








Problem 15: A 20-kg boy slides down a playground slide with a constant acceleration a = *2.9* m/s^2 parallel to the surface of the slide. The boy starts sliding with an initial speed of v_0. Refer to the figure.



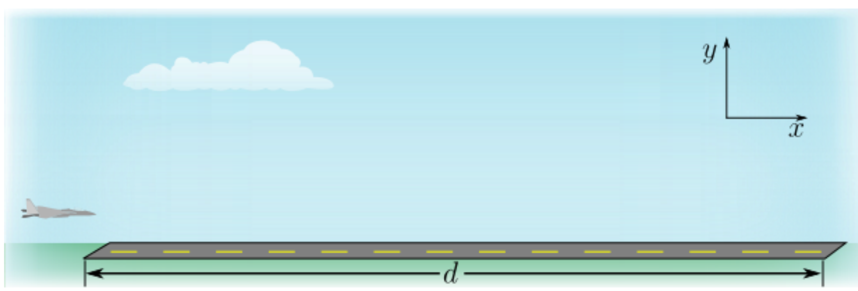
Part (a) Enter an expression for the child's speed squared, v_f^2, at the bottom of the slide in terms of a, v_0, and the length of the slide, d.
Expression :
v_f^2 = ____

Select from the variables below to write your expression. Note that all variables may not be required.
β, θ, a, b, d, g, h, j, k, m, n, P, S, t, v_0

Part (b) If the slide is 4.0 m long and the boy's final speed is v_f = 5.0 m/s, what is his initial speed, in meters per second?
Numeric : A numeric value is expected and not an expression.
v_0 = ____ m/s

Part (c) When starting from rest, how long, in seconds, does it take the boy to reach the bottom of the slide?
Numeric : A numeric value is expected and not an expression.
Δt = ____ s

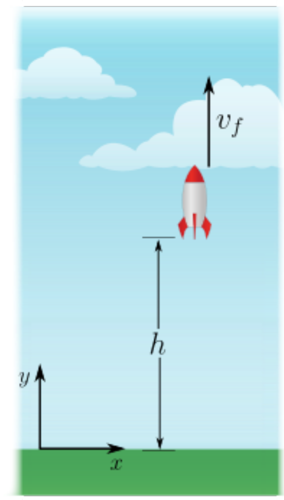
Problem 16: At the equator, the radius of the Earth is approximately 6370 km. A plane flies at a very low altitude at a constant speed of $v = 209$ m/s. Upon landing, the plane can produce an average deceleration of magnitude $a = 18$ m/s^2.



Part (a) How long, in seconds, will it take the plane to circle the Earth at the equator?
Numeric : A numeric value is expected and not an expression.
Δt = ____ s

Part (b) What is the minimum landing distance, in meters, this plane needs to come to rest? Assume that, when the plane *initially* touches the ground, it is moving at the same speed as it was when it was flying.
Numeric : A numeric value is expected and not an expression.
d = ____ m

Problem 17: A student launches a small rocket which starts from rest at ground level. At a height $h = 1.09$ km, the rocket reaches a speed of $v_f = 361$ m/s. At that height, the rocket runs out of fuel, so there is no longer any thrust propelling it. Take the positive direction to be upward. The drawing is *not* to scale.



Part (a) Assuming constant acceleration, what is the rocket's acceleration, in meters per squared second, during the period from its launch until it runs out of fuel?
Numeric : A numeric value is expected and not an expression.
a_1 = ____ m/s^2

Part (b) After the rocket's engine turns off at a height of $h = 1.09$ km, it continues to move upward due to the velocity that it reached. What is the rocket's acceleration, in meters per squared second, during the period from engine shutoff until it returns to the ground? Ignore air resistance.
Numeric : A numeric value is expected and not an expression.
a_2 = ____ m/s^2

Part (c) Calculate the maximum height, in meters above ground level, that the rocket reaches.
Numeric : A numeric value is expected and not an expression.
h_{max} = ____ m

Problem 18: A child flings a penny off of the Eiffel tower (h = 324 m) with a downward velocity of magnitude V_0 = 5 m/s.

Part (a) Select from below the correct expression for the time t, it takes for the penny to reach the ground. Neglect air resistance.
SchematicChoice :

$$t = \frac{V_0^2 + 2gh - V_0}{g}$$

$$t = \frac{\sqrt{V_0^2 + 2gh} - V_0}{2g}$$

$$t = \frac{\sqrt{V_0^2 + 4gh} - V_0}{g}$$

$$t = \frac{\sqrt{V_0^2 + 2gh} - V_0}{g}$$

$$t = \frac{\sqrt{V_0 + 2gh} - V_0}{g}$$

Part (b) Calculate the time t, in seconds, that it takes for the penny to fall.
Numeric : A numeric value is expected and not an expression.
t = ____

Part (c) Find the speed at which the penny strikes the ground V_f, in meters per second, using the initial velocity, V_0, and the drop distance, h.
Numeric : A numeric value is expected and not an expression.
V_f = ____