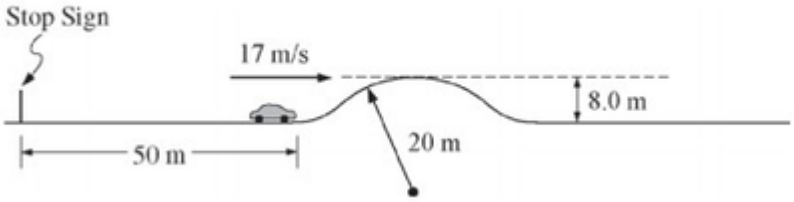
quest 2

1.



You are assigned to do some calculations for a movie stunt that involves a car on a straight road. The road, pictured above, has a hill that rises 8.0 m above the flat region. The top of the hill is a circular arc of radius 20 m. You need to determine whether a car traveling under certain conditions will lose contact with the road at the top of the hill. There is a stop sign 50 m from the beginning of the hill. You are to assume that a car of mass 1600 kg accelerates uniformly from rest at the stop sign, has a speed of when it reaches the beginning of the hill, and then coasts with the engine off. Assume energy losses due to friction and air resistance are negligible.

a. Calculate the magnitude of the acceleration of the car during the first 50 m.

b. Calculate the time it takes the car to reach the beginning of the hill

c. Calculate the magnitude of the net force required to accelerate the car during the first 50 m.

d. On the dot below that represents the car, draw and label the forces (not components) that act on the car at the top of the hill if it travels over the hill without losing contact.

e. Calculate the minimum speed the car must have at the top of the hill to momentarily lose contact with the road. If you need to draw anything other than what you have shown in

quest 2

part (d) to assist in your solution, use the space below. Do NOT add anything to the figure in part (d).

f. Calculate the speed the car must have at the beginning of the hill in order to have the speed at the top of the hill you calculated in part (e).

The text box below should be used for notes only and not your final response.

Please respond on separate paper, following directions from your teacher.

Upload your final response here.

Please respond on separate paper, following directions from your teacher.

Part A

One point is earned for using the correct equation to solve for the acceleration

$$v^2 = v_0^2 + 2ax$$

$$v_0 = 0, \text{ so } a = \frac{v^2}{2x}$$

$$a = \frac{(17 \text{ m/s})^2}{(2)(50 \text{ m})}$$

One point is earned for the correct answer with units

a = 2.89 m/s^2

0	1	2 ✓

The student earns all of the following points:

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quest 2

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Part B

One point is earned for using a correct expression to calculate the time

$$x = x_0 + v_0 t + \frac{1}{2}at^2$$

One point is earned for substituting values consistent with the answer from part (a)

$$x = 0 + (0)t + \frac{1}{2}at^2$$

$$t = \sqrt{\frac{2x}{a}}$$

$$t = \sqrt{\frac{(2)(50 \text{ m})}{(2.89 \text{ m/s}^2)}}$$

$$t = 5.88 \text{ s}$$

0	1	2 ✔

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quest 2

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$$t = 5.88\text{ s}$$

Part C

One point is earned for using Newton's 2nd law

$F = ma$

One point is earned for substituting the correct value for m and a value for a consistent with part (a)

F = (1600 kg)(2.89 m/s^2)

F = 4624 N

0	1	2 ✔

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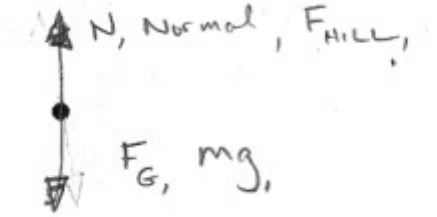
Part D

quest 2



One point is earned for a correctly labeled vector representing the normal force

One point is earned for a correctly labeled vector representing the weight of the car

One point is earned for no incorrect or extraneous vectors or labeling

0	1	2	3 ✔

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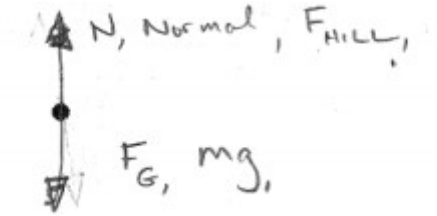

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Part E

One point is earned for equating the centripetal force exerted on the car to the net force

$$F_C = W + N$$

$$\frac{mv^2}{r} = mg + N$$

quest 2

One point is earned for setting the normal force equal to zero

$$\frac{mv^2}{r} = mg + 0$$

Solving for *v* and substituting

$$v = \sqrt{rg}$$
$$v = \sqrt{(20\ \text{m})\left(9.8\ \text{m/s}^2\right)}$$

One point is earned for a correct answer with units

v = 14 m/s

0	1	2	3 ✔

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quest 2

v = 14 m/s

Part F

One point is earned for any indication of the use of conservation of energy

One point is earned for a correct expression for the conservation of energy

$$K_1 = K_2 + U_2$$
$$\frac{1}{2}mv_1^2 = \frac{1}{2}mv_2^2 + mgh_2$$

One point is earned for correct substitution, with consistent with part (e)

$$v_1^2 = v_2^2 + 2gh_2$$
$$v_1 = \sqrt{v_2^2 + 2gh_2}$$
$$v_1 = \sqrt{(14\ \text{m/s})^2 + (2)\left(9.8\ \text{m/s}^2\right)(8.0\ \text{m})}$$
$$v_1 = 18.8\ \text{m/s}$$

0	1	2	3 ✔

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quest 2

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