CollegeBoard
Advanced Placement Program

AP® Physics B (Operational)
2004 Sample Student Responses

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A1

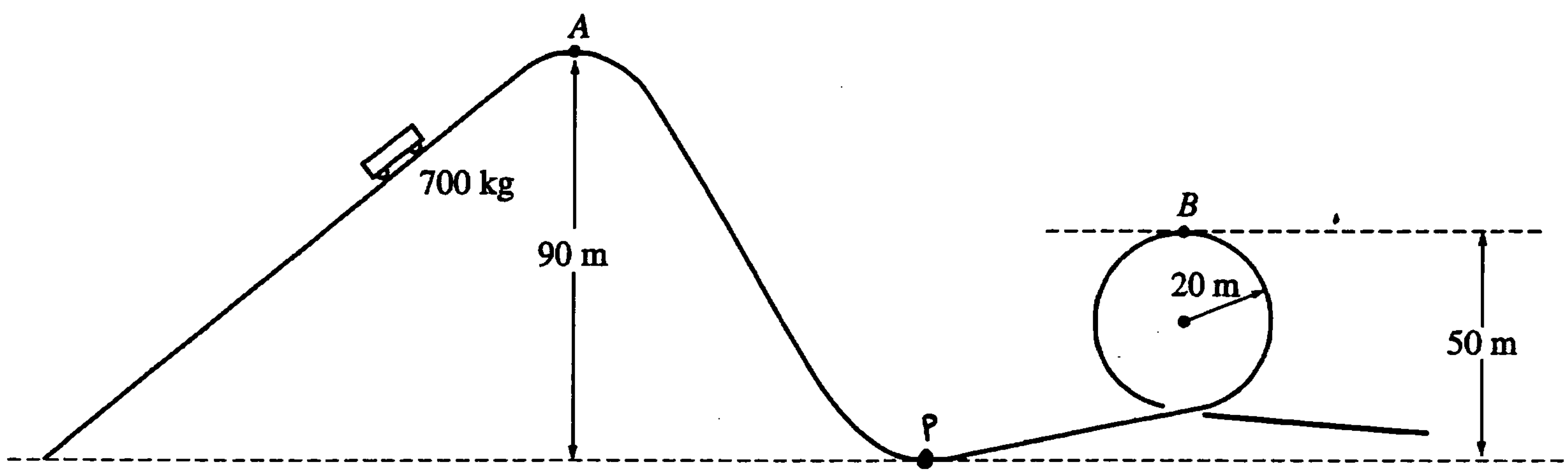
PHYSICS B

SECTION II

Time—90 minutes

6 Questions

Directions: Answer all six questions, which are weighted according to the points indicated. The suggested time is about 17 minutes for answering each of questions 1-4, and about 11 minutes for answering each of questions 5-6. The parts within a question may not have equal weight. Show all your work in this booklet in the spaces provided after each part, NOT in the green insert.



1. (15 points)

A roller coaster ride at an amusement park lifts a car of mass 700 kg to point A at a height of 90 m above the lowest point on the track, as shown above. The car starts from rest at point A, rolls with negligible friction down the incline and follows the track around a loop of radius 20 m. Point B, the highest point on the loop, is at a height of 50 m above the lowest point on the track.

(a)

i. Indicate on the figure the point P at which the maximum speed of the car is attained.

ii. Calculate the value v_{max} of this maximum speed.

$mgh_{top} = \frac{1}{2}mv^2$

$V = \sqrt{2gh}$

$= \sqrt{2(9.8\ m/s^2)(90\ m)}$

$v = \boxed{42\ m/s}$

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A2

(b) Calculate the speed v_B of the car at point B.

$\frac{1}{2}mv^2 + mgh = \frac{1}{2}mv^2$ @ P

$\frac{1}{2}(700\text{ kg})v^2 + 343{,}000 = 617400\text{ J}$

$V_B = 28\text{ m/s}$

~~$\frac{1}{2}mv^2$ @ P $= \frac{mv^2}{r}$ @ B~~

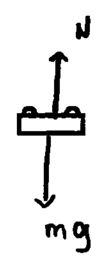
~~$\frac{1}{2}(700\text{ kg})(42\text{ m/s})^2 = \frac{mv^2}{r}$~~

~~$617400\text{ J} = \frac{mv^2}{r}$~~

~~$v = 132.8\text{ m/s}$~~

(c)

i. On the figure of the car below, draw and label vectors to represent the forces acting on the car when it is upside down at point B.



ii. Calculate the magnitude of all the forces identified in (c)i.

$$\frac{mv^2}{r} = \frac{(700\text{ kg})(28\text{ m/s})^2}{20\text{ m}} = 27440\text{ N}$$

$mg = 6860\text{ N}$

$N = 20580\text{ N}$

(d) Now suppose that friction is not negligible. How could the loop be modified to maintain the same speed at the top of the loop as found in (b)? Justify your answer.

~~The radius of the loop could be made smaller,~~

The loop could me constructed so that the bottom of the loop is not 10 m above the ground. Therefore, a larger portion of the system's energy can be focused on its velocity. (see initial equation for part b)

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B1

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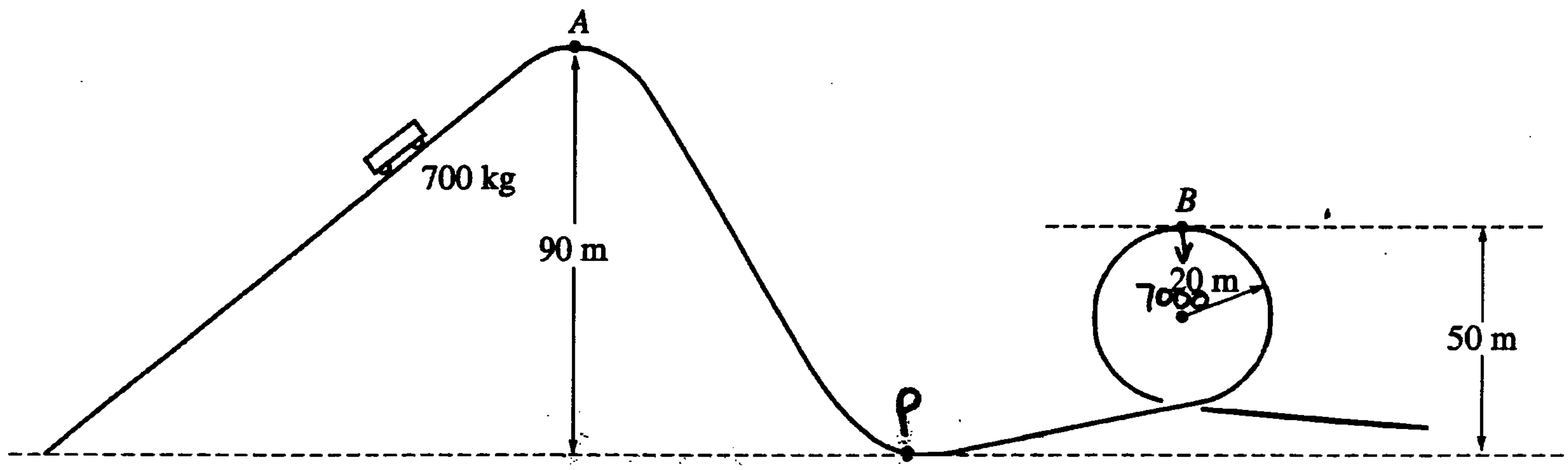

1. (15 points)

A roller coaster ride at an amusement park lifts a car of mass 700 kg to point A at a height of 90 m above the lowest point on the track, as shown above. The car starts from rest at point A, rolls with negligible friction down the incline and follows the track around a loop of radius 20 m. Point B, the highest point on the loop, is at a height of 50 m above the lowest point on the track.

(a)

i. Indicate on the figure the point P at which the maximum speed of the car is attained.

ii. Calculate the value v_{max} of this maximum speed.

$PE = KE$

$mgh = \frac{1}{2}mv^2$

$gh = \frac{1}{2}v^2$

$2gh = v^2$

$v = \sqrt{2gh}$

$v = \sqrt{2(10)(90)}$

$v = \sqrt{1800}$

$\boxed{v = 42.426 \text{ m/s}}$

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B2

(b) Calculate the speed v_B of the car at point B.

$\Delta PE = KE$

$PE_A - PE_B = KE$

$mgh_A - mgh_B = KE$

$(700 \times 10 \times 90) - (700 \times 10 \times 50) = KE$

$630000 - 350000 = KE$

$280000 = KE$

$\frac{1}{2}mv^2 = 280000$

$\frac{1}{2}(700)(v^2) = 280000$

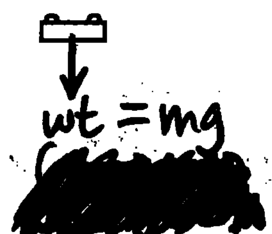
$\frac{350v^2}{350} = \frac{280000}{350}$

$v^2 = 800$

$\boxed{v = 28.28 \text{ m/s}}$

(c)

i. On the figure of the car below, draw and label vectors to represent the forces acting on the car when it is upside down at point B.



ii. Calculate the magnitude of all the forces identified in (c)i.

$wt = mg$

$wt = 700 \times 10$

$wt = 7000\text{N}$

(d) Now suppose that friction is not negligible. How could the loop be modified to maintain the same speed at the top of the loop as found in (b)? Justify your answer.

The speed at the top of the loop could remain the same if the height at point A was increased. The car would gain more momentum, and speed, and then when friction acted against the car it would slow to the desired speed. More potential energy at the top would result in greater kinetic energy at the bottom and greater speed. (conservation of energy).

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