AP Physics - Pre Exam - Unit - KEY

#1.
ANS: C
As long as a ramp is sloped downward, the speed of the cart will increase as it slides with negligible friction. The ramp angle, though, has a direct bearing on the acceleration of the cart. Steep angles result in large accelerations while shallow angles result in small accelerations. This ramp has a continuously decreasing angle of inclination which results in a decreasing acceleration.

DIF: Medium OBJ: 3.A.1.1 NAT: S.P. 1.5, 2.1, 2.2
TOP: Kinematics 1-D & 2-D MSC: NOT:

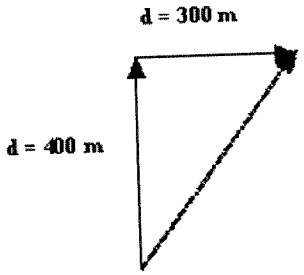
#2
ANS: D
The equation

$$\Delta y = v_i t + \frac{1}{2} a t^2$$

indicates that the height of the drop, y, is directly related to the square of the time. Because the drop time doubles, squaring the drop time requires four times as much height, $4y$.

DIF: Medium OBJ: 4.A.2.1 NAT: S.P. 6.4 TOP: Kinematics 1-D & 2-D
MSC: NOT:

#3
ANS: B
Average velocity is defined as *total displacement* divided by *elapsed time*. So, this is a vector problem.
Draw!



So, with regard to *displacement*, we have a 3-4-5 right triangle. Therefore,

$$v_{avg} = \frac{\Delta d}{t} = \frac{500\,\text{m}}{150\,\text{s}} = 3.3\,\frac{\text{m}}{\text{s}}$$

DIF: Hard OBJ: 4.A.2.1 NAT: S.P. 6.4 TOP: Kinematics 1-D & 2-D

#4
ANS: C
The slope of a position versus time graph represents velocity. Here, the data table suggests that the position is increasing in a uniform manner (4 cm every 0.5 s). Calculating the velocity (change in position/change in time) near $t = 0.5$ s results in a velocity of 8 cm/s.

DIF: Easy OBJ: 3.A.1.3 NAT: S.P.5.1 TOP: Kinematics 1-D & 2-D
MSC: NOT:

AP Physics - Pre Exam Unit 1 - KEY

#5 ANS: B

The slope of a velocity versus time graph represents the acceleration. For ramps inclined at large angles, the acceleration (slope) should be large. Here, the angle abruptly decreases at one point resulting in a corresponding decrease in the acceleration and thus the slope of the velocity versus time graph.

DIF: Easy OBJ: 3.A.1.3 NAT: S.P. 5.1 TOP: Kinematics 1-D & 2-D

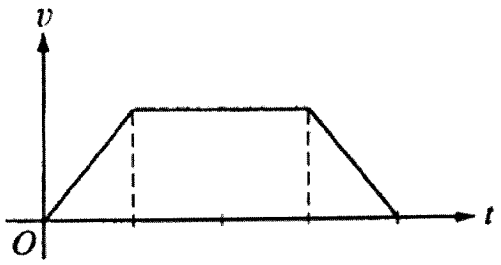
#6 ANS: C

Because the ground is the reference for position and up is positive, the balloon has a positive position when it strikes the second floor of the building. After passing the peak of its trajectory, the balloon is now falling, so it has a downward (–) velocity. Finally, the acceleration of the balloon is due to gravitation alone which is in the downward (–) direction. The correct answer is +, –, – for vertical position, velocity, and acceleration, respectively.

DIF: Medium OBJ: 3.A.1.1 NAT: S.P. 1.5, 2.1, 2.2
TOP: Kinematics 1-D & 2-D MSC: NOT:

#7. ANS: B

Remember, the slope of a x vs. t graph is the velocity! Where the graph is curved indicates acceleration and where it is linear zero acceleration. The velocity time graph for the motorcycle is



The motorcycle has an increasing positive velocity followed by a constant velocity, followed by an increasing negative velocity. The graph is not a picture of the motorcycle's path. Between the origin and the first dotted line, the velocity is increasing which indicates acceleration, so the d vs. t graph is an open parabola. Between the dotted lines, the velocity was constant (no acceleration),so this segment of the x vs. t graph is a straight line.

Also consider that this is the fastest the object moved, so the slope should be steep. Between the last dotted line and the last data point, the velocity is constant but decreasing, so the x vs. t graph for this portion is a downward parabola.

DIF: Medium OBJ: 3.A.1.1 NAT: S.P. 1.5, 2.1, 2.2
TOP: Kinematics 1-D & 2-D MSC: NOT:

AP Physics - Pre Exam Unit 1 - KEY

#8. ANS: B
It's all about kinematics:

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

For the first second,

$$\Delta x_1 = \frac{1}{2}(0)t^2 + (24\ \text{m/s})(1\text{s}) = 24\,\text{m}$$

For the next 10 seconds,

$$\Delta x_{2 \rightarrow 11} = \frac{1}{2}(-6\ \text{m/s}^2)(10\,\text{s})^2 + (24\ \text{m/s})(10\,\text{s})$$

$$\Delta x_{2 \rightarrow 11} = (-300\,\text{m}) + (240\,\text{m}) = -60\,\text{m}$$

So, the grand total is 24 m + (–60 m) = –36 m

DIF: Medium OBJ: 4.A.2.1 NAT: S.P. 6.4 TOP: Kinematics 1-D & 2-D
MSC: 80% answered correctly NOT: AP C 1993 #2

#9. ANS: D
For a projectile which lands at the same height from which it was launched, the flight time is determined by the vertical component of the initial velocity. Increasing the launch angle results in an increase in the vertical component of this velocity. Note that the maximum possible time and height is achieved when the ball is launched straight up, i.e. 90° above the ground.

DIF: Easy OBJ: 3.A.1.1 NAT: S.P. 1.5, 2.1, 2.2
TOP: Kinematics 1-D & 2-D MSC:

AP Physics - Pre Exam Unit 1 - KEY

#10. ANS: D
The initial horizontal velocity will remain constant throughout flight and has no effect on how long the object will stay in the air. The horizontal velocity only affects how far away the object will land. Because you know the height, you can easily solve for the time the object is in the air.

$$t = \sqrt{\frac{2y}{g}} = \sqrt{\frac{20\,\text{m}}{10\ \text{m/s}^2}} = \sqrt{2}\ \text{s} = 1.4\ \text{s}$$

Because the object has no initial velocity in the vertical direction, this is simply a free-fall problem. So,

$$v = gt = \left(10\ \text{m/s}^2\right)(1.4\,\text{s}) = 14\,\text{m/s}$$

is the vertical velocity.

DIF: Medium OBJ: 4.A.1.1 NAT: S.P. 6.4 TOP: Kinematics 1-D & 2-D
MSC:

#11. ANS: B
Don't overthink this one, it was supposed to be easy! You were given this equation

$$x = 3.0t^2 + 1.5t + 4.5$$

which looks suspiciously like this kinematics equation, only rearranged:

$$x = x_o + vt + \frac{1}{2}at^2$$

$x = 4.5 + 1.5t + 3.0t^2$

$\frac{1}{2}a = 3.0$

$a = (3.0)2$

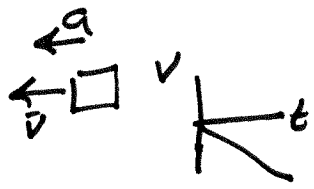
$a = 6$

So, the $3.0t^2$ term is equivalent to $\frac{1}{2}a$, thus $a = 6.0\ \text{m/s}^2$.

DIF: Medium OBJ: 3.A.1.1 NAT: S.P. 1.5 TOP: Kinematics 1-D & 2-D
MSC: 91% answered correctly NOT: AP C 2004 #24

#12 C Accelerating slope of the graph

#13 C moving left, so $\vec{v}$ must be negative



accelerating left, so x must look like

AP Physics - Pre Exam Unit - KEY

MULTIPLE RESPONSE

#14 ANS: A, B
Because a launch angle of 45° will produce maximum range, both increasing and decreasing the launch angle will decrease the range of the dart.

DIF: Hard OBJ: 3.A.1.3 NAT: S.P.5.1 TOP: 1 D and 2 D Kinematics

#15 ANS: C, D
The distance traveled is proportional to the area between the curve and the horizontal axis, which represents 0 displacement. The elevator descended, stopped at $t = 2$ s, traveled upward, passing its starting point at $t = 4$ s.The slope indicates that the acceleration is constant during the time interval.

DIF: Medium OBJ: 3.A.1.3 NAT: S.P. 5.1 TOP: 1 D and 2 D Kinematics

AP Physics - Unit 1 Pre Exam - KEY

FRQ

#1 Part (a)i

0	1 ✓

Student response accurately includes the following criteria.

1 point is earned for a correct substitution of the known quantities into an appropriate kinematic equation or pair of equations that can be used to solve for the acceleration due to gravity on Planet X.

Example Response:

$y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$

$a_y = \frac{2(y - y_0 - v_{0y}t)}{t^2}$

$a_x = \frac{2(0\,\text{m} - 100\,\text{m} - (15\,\text{m/s})(10\,\text{s}))}{(10\,\text{s})^2} = 5\,\text{m/s}^2$

Part (a)ii

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

Correct Answer: $v_d > v_u$

Note: No credit for answer without explanation.

0	1 ✓

Student response does not accurately include the following criteria.

1 point is earned for a correct explanation.

Example Response:

Correct Answer: $v_d > v_u$

Note: No credit for answer without explanation.

When the rock is thrown upward, it will eventually reach its maximum height above the ground. As it falls back down to the ground its speed at the same vertical height at which it was thrown will be $15\,\text{m/s}$. Since the rock continues to fall $100\,\text{m}$ below its initial vertical position, the rock's speed will increase above its initial speed of $15\,\text{m/s}$.

Part (b)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

AP Physics - Unit 1 Pre Exam - Key
FRQ

#1

B)

0	1	2	3	4	5 ✓

Student response accurately includes all of the following criteria.

1 point is earned for indicating that the acceleration due to gravity for the rock is greater on Earth than on Planet X.

1 point is earned for indicating that the time that the rock is in free fall on Earth is less than that on Planet X.

1 point is earned for indicating that the maximum distance above the ground of the rock on Earth is less than that on Planet X.

1 point is earned for indicating that the speed at which the rock reaches the ground on Earth is greater on Earth than on Planet X.

1 point is earned for a response that has a sufficient paragraph structure, as described in the published requirements for the paragraph-length response.

Example Response:

The acceleration due to gravity for the rock is greater on Earth than on Planet X. Since the acceleration due to gravity is greater on Earth, the time it takes for the rock to reach its maximum height is less on Earth than on Planet X. Therefore, the maximum distance above the ground that the rock attains is less on Earth than on Planet X. This also means that the total time that the rock is in free fall is less on Earth than on Planet X. When the rock is at a position of $100\ \mathrm{m}$ above the surface of Earth and Planet X as it falls toward the ground, $v_y^2 = v_{y0}^2 + 2a_y(y - y_0)$ can be used to show that for the same height above the ground and for the same initial velocity of $15\ \mathrm{m/s}$ downward for the rock at this position, the rock will reach the ground with a greater speed on Earth than it does on Planet X, since $v_y \sim \sqrt{a_y}$.

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#2 FRQ

Part (a)

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

Note: To earn the first point, it must be possible to use the written equations to arrive at a correct final equation.

Student response accurately includes two of the following criteria.

- ☐ 1 point is earned for using appropriate kinematics equations for the sphere's horizontal and vertical motions.
- ☐ 1 point is earned for combining the equations to get a correct equation for y in terms of x, v_0 , and g.

2pts

Example Responses:

$x = v_{x0}t = v_0 t$

$y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2 = \frac{1}{2}gt^2$

$t = x/v_0$

$y = \frac{1}{2}gt^2 = \frac{1}{2}g(x/v_0)^2$ or $\frac{1}{2}\frac{gx^2}{v_0^2}$

Part (b)

- ☐ 1 point is earned for listing relevant/appropriate equipment that matches the measured quantities.
- ☐ 1 point is earned for a plausible/practical way to directly or indirectly determine whether the claim is true, using the available equipment.
- ☐ 1 point is earned for measuring x, the horizontal displacement of the sphere.
- ☐ 1 point is earned for measuring y, the vertical displacement of the sphere, for at least two different values of y.

5pts

- ☐ 1 point is earned for attempting to reduce uncertainty using at least three different launch heights, or at least two experimental trials at each of two launch heights.

Example Response:

Quantity to be Measured	Symbol for Quantity	Equipment for Measurement
Initial height above floor for bottom of sphere	y	Meter stick
Horizontal distance from launch point to where sphere hits the floor	x	Meter stick

1. Move the launcher to the maximum height possible on the stand.

2. With the sphere in the launcher, use the meter stick to measure the height y from the floor to the bottom of the sphere. Also, mark the spot on the floor below the center of the sphere.

3. Launch the sphere and note approximately where the sphere hits the floor.

4. Place the two sheets of paper at the location where the sphere hit the floor.

5. Launch the sphere again, so that a mark is made on the plain paper when the sphere hits the sheets of paper. If the sphere misses the paper sheets, reposition the sheets and repeat the launch until the sphere hits the sheets.

6. Put the sphere in the launcher, and use the meter stick to measure the horizontal distance x from the mark made in step 1 to the mark on the paper where the sphere hit the floor.

7. Repeat steps 2 through 6 for launch heights of 20%, 40%, 60%, and 80% of the maximum launch height.

AP Physics - Pre Exam-Unit 1 - KEY

#2 FRQ

Part (c)ii

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

0	1	2 ✓

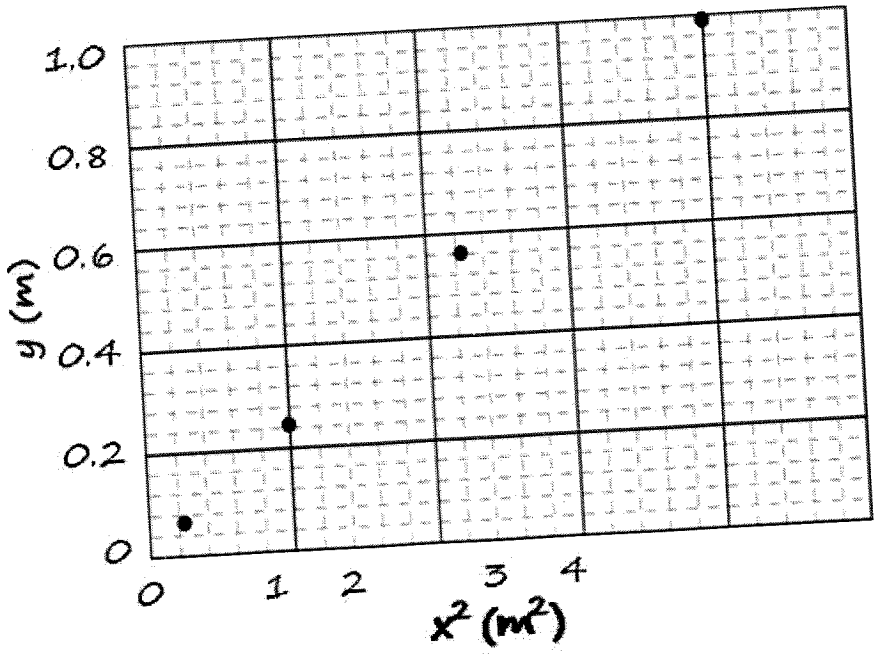
Student response accurately includes both of the following criteria.

2pts

- ☐ 1 point is earned for using a correct scale that uses more than half the grid and for correctly labeling the axes, including units, as appropriate.
- ☐ 1 point is earned for correctly plotting the data or quantities calculated from the data.

Example Response:

Horizontal Displacement x (m)	Vertical Displacement y (m)	x^2 (m^2)	
0.50	0.065	0.25	
1.00	0.245	1.00	
1.50	0.560	2.25	
2.00	0.990	4.00	



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#2 FRQ

Part (c)iii

Select a point value to view scoring criteria, solutions, and/or examples and to score the response.

Note: if students graph y versus x which results in a parabola, it is not sufficient for a student to simply note that a graph of y versus x is curved, or that the graph "looks like a parabola".) Students must say that y increases by a factor of approximately 4 whenever x is doubled, or similar.

1 Pt

0	1 ✓

Student response accurately includes the following criteria.

- ☐ 1 point is earned for a reasonable justification that y is proportional to x^2 .

Example Response:

The data points in a graph of y versus x^2 lie along a straight line.

Part (d)

0	1	2 ✓

Student response accurately includes both of the following criteria.

- ☐ 1 point is earned for a graph of v_x that is a constant and less in magnitude than indicated by the dashed line.
- ☐ 1 point is earned for a graph of v_y that is identical to the graph indicated by the dashed line.

2 pts

Example Response: