AP® Physics C: Mechanics
2002 Sample Student Responses

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Mech 3.

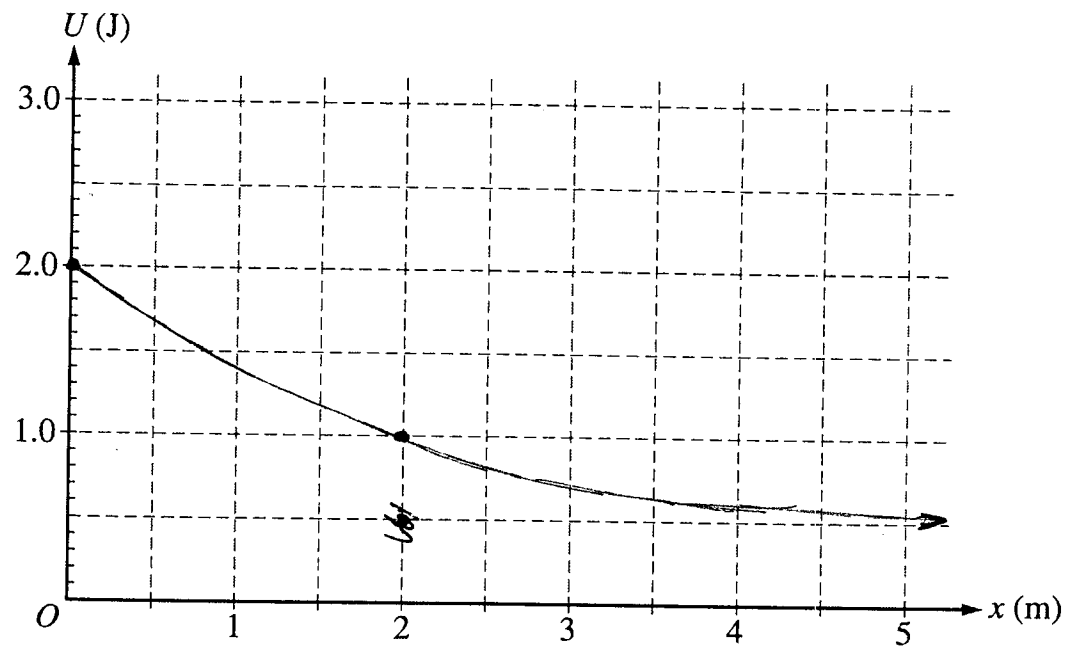
An object of mass 0.5 kg experiences a force that is associated with the potential energy function $U(x) = \dfrac{4.0}{2.0 + x}$, where U is in joules and x is in meters.

(a) On the axes below, sketch the graph of $U(x)$ versus x.

$2.5 = \frac{25}{10} = \frac{5}{2}$

$10 + 2x = 5$

$2x =$



(b) Determine the force associated with the potential energy function given above.

$F = -\frac{dU}{dx}$ $\quad U(x) = \frac{4}{2+x} = \frac{4}{r}$

$r = 2 + x$ $\quad \frac{dU}{dr} = \frac{-4}{r^2}$

$\frac{dr}{dx} = 1$

$\frac{dU}{dx} = \frac{-4}{(2+x)^2}$ $\quad \boxed{F = -\frac{dU}{dx} = \frac{4}{(2+x)^2}}$

(c) Suppose that the object is released from rest at the origin. Determine the speed of the particle at $x = 2$ m.

$U(0) = 2\ J$

$U(2) = 1\ J$

$\Delta K.E. = 1\ J$

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

$= \frac{1}{2}(.5\ kg) \cdot v^2$

~~$v^2 = 4\frac{m^2}{s^2} = 2\frac{m}{s}$~~

$v^2 = 4\frac{m^2}{s^2}$

$\boxed{v = 2\frac{m}{s}}$

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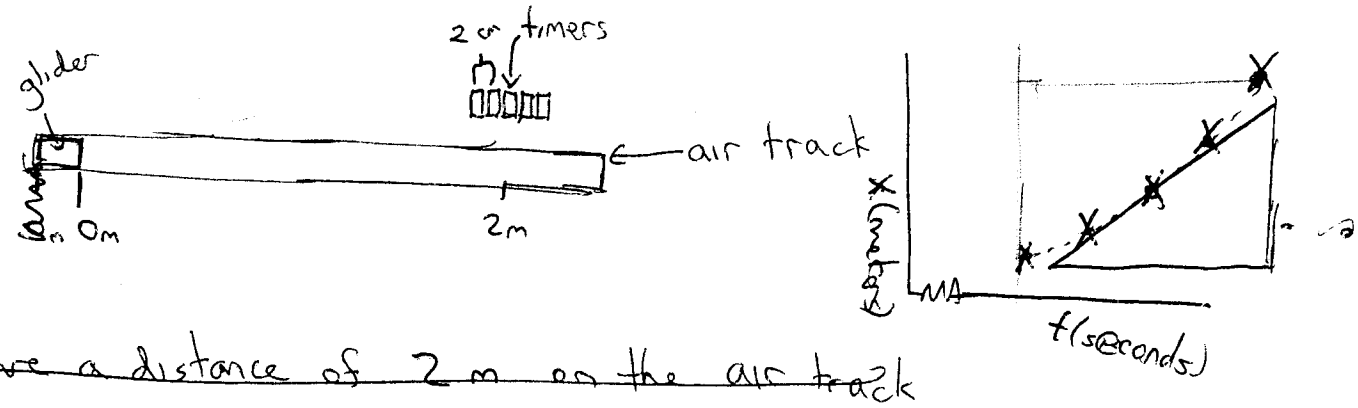
In the laboratory, you are given a glider of mass 0.5 kg on an air track. The glider is acted on by the force determined in part (b). Your goal is to determine experimentally the validity of your theoretical calculation in part (c).

(d) From the list below, select the additional equipment you will need from the laboratory to do your experiment by checking the line next to each item. If you need more than one of an item, place the number you need on the line.

1 Meterstick	___ Stopwatch	5 Photogate timer	___ String	1/4 Spring
___ Balance	1/4 Wood block	___ Set of objects of different masses		

(e) Briefly outline the procedure you will use, being explicit about what measurements you need to make in order to determine the speed. You may include a labeled diagram of your setup if it will clarify your procedure.



~~1. measure a distance of 2m on the air track~~
~~2. set up the one timer at the 2m mark and set the others 2 on each side of it, but very close~~
~~3. start all 5 timers at the same time the glider is released~~
~~4. as the glider passes in front of each timer, it will the timers will record the time~~

1. measure a distance of 2m on the air track
2. set one photogate timer at the 2m mark, another at 1.98m, ~~another~~ a third at 1.96 m, a fourth at 2.02m, and the fifth at 2.04m
3. place the glider with the front edge on the 0m mark
4. release the glider ~~and~~ at the same time as you start the timers
5. record the time recorded by each timer and plot the five points on a position-time graph.
6. approximate ~~a tangent line~~ graph of the position through the five points
7. draw a tangent line at $x = 2m$ on the graph. ~~and measu~~
8. measure the Δx and Δt values of this tangent line
9. Use $v = \frac{\Delta x}{\Delta t}$ to calculate the glider's velocity at $x = 2m$

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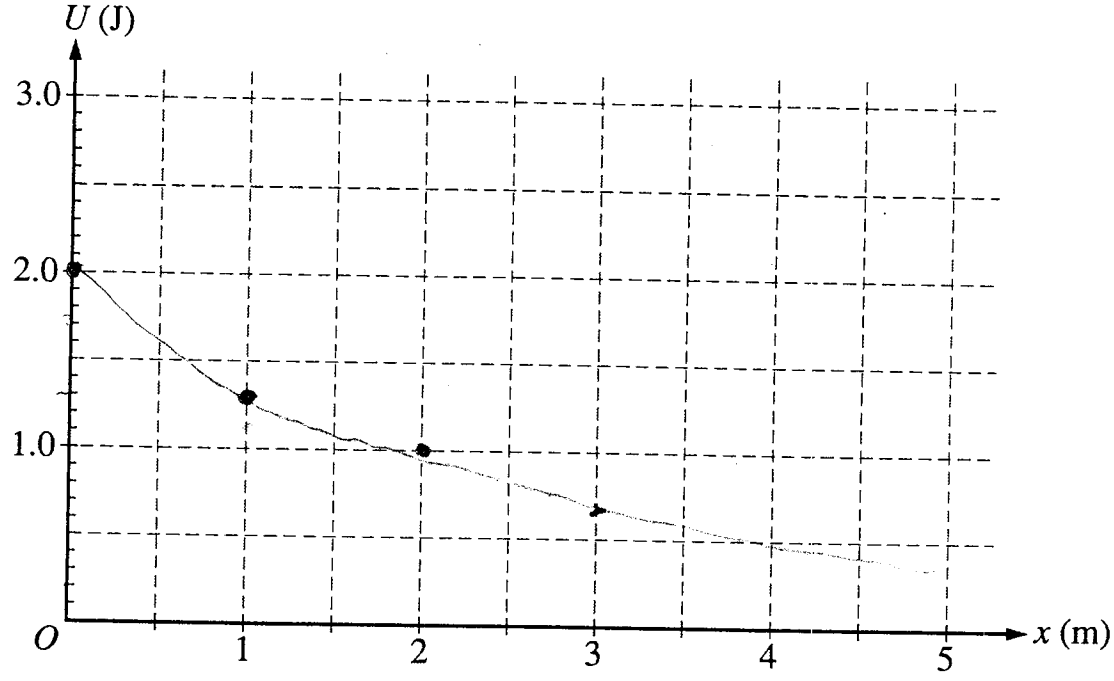
Mech 3.

An object of mass 0.5 kg experiences a force that is associated with the potential energy function $U(x) = \dfrac{4.0}{2.0 + x}$, where U is in joules and x is in meters.

(a) On the axes below, sketch the graph of $U(x)$ versus x.



(b) Determine the force associated with the potential energy function given above.

$$F = -\frac{dU}{dx} = -4(-1)(2+x)^{-2} = \frac{4}{(2+x)^2}$$

(c) Suppose that the object is released from rest at the origin. Determine the speed of the particle at $x = 2$ m.

$\Delta U = \Delta KE$

$2\text{J} - 1\text{J} = \frac{1}{2}mv^2 = 0.25v^2$

$v = 2$ m/s

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(d) From the list below, select the additional equipment you will need from the laboratory to do your experiment by checking the line next to each item. If you need more than one of an item, place the number you need on the line.

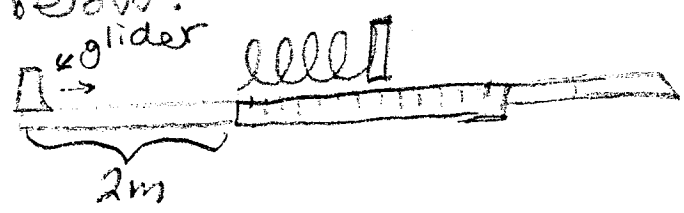
✓ Meterstick ___ Stopwatch ___ Photogate timer ___ String ✓ Spring

✓ Balance ___ Wood block ✓ Set of objects of different masses

(e) Briefly outline the procedure you will use, being explicit about what measurements you need to make in order to determine the speed. You may include a labeled diagram of your setup if it will clarify your procedure.

1. First objects of different masses would be massed using the balance, and sequentially hung from the spring. The different lengths the spring vertically streched would be used to calculate its spring constant according to $mg = -kx$

2. The spring and meter stick would be set up next to the air track as shown below:



After the spring was secured such that at equilibrium is left edge was 2m from the edge of the track the glider would be allowed to move.

3. The maximum compression of the spring would be measured. Using this information, and the known mass of the glider, the glider's speed at 2m can be calculated.

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