Nov 19, 2015 LB 273, Physics I

Prof. Vashti Sawtelle
Prof. Leanne Doughty

Today:

Chapter 10 – Potential Energy and Energy Conservation

Irish Phrasebook

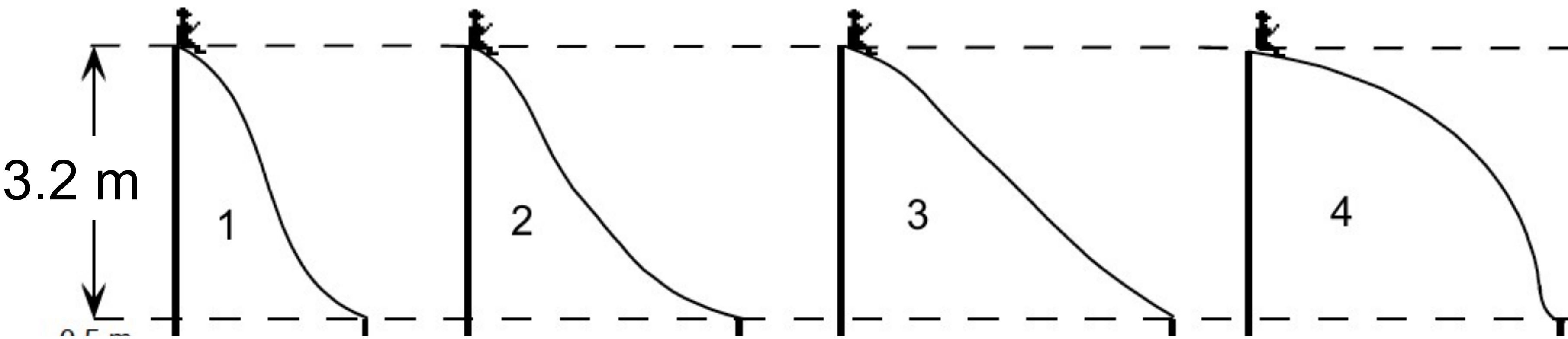
Aw, sure look it

I have no idea what it means but it's an acceptable response to any statement or comment

Announcements

- LON-CAPA HW for Ch 9 & Ch 10 due tonight
- On-paper HW due on Monday 23rd
- Extra Office Hours
  - Friday 20th 1:00pm-4:00pm

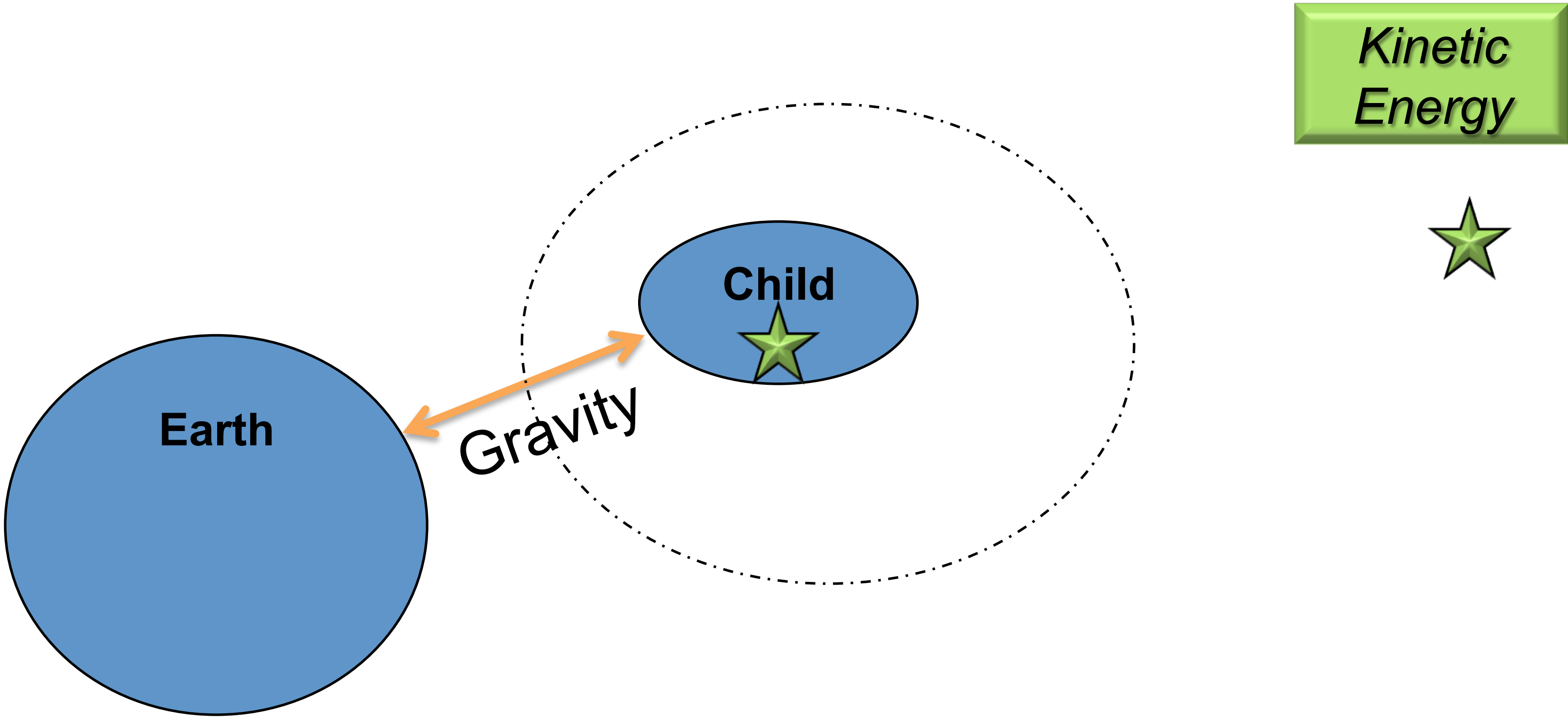
A young child wants to select one of the (frictionless) playground slides illustrated below to give her the greatest possible speed when she reaches the bottom of the slide. Which should she choose?



A. 1
B. 2
C. 3
D. 4
E. It doesn't matter. It would be the same for each.

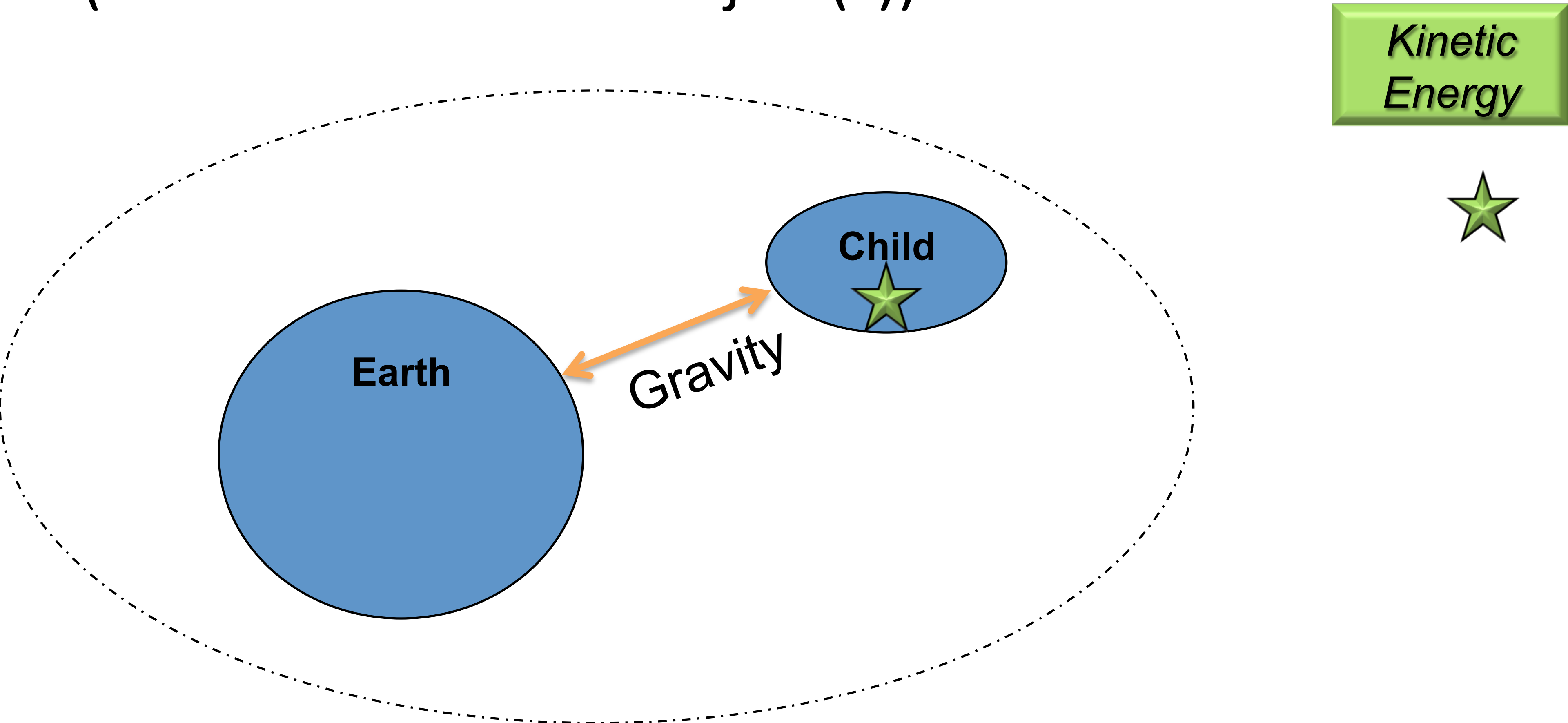
What is in our system?

An external force is doing work and changes the total energy within the system

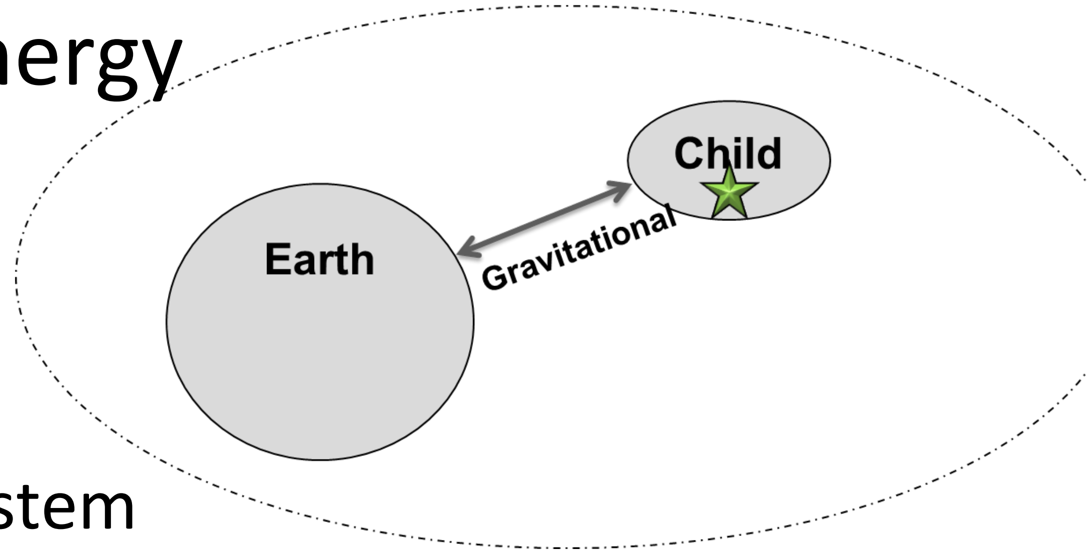


Energy Conservation for System

Total energy of system is conserved unless external forces move object(s) within the system (i.e. do work on the object(s))



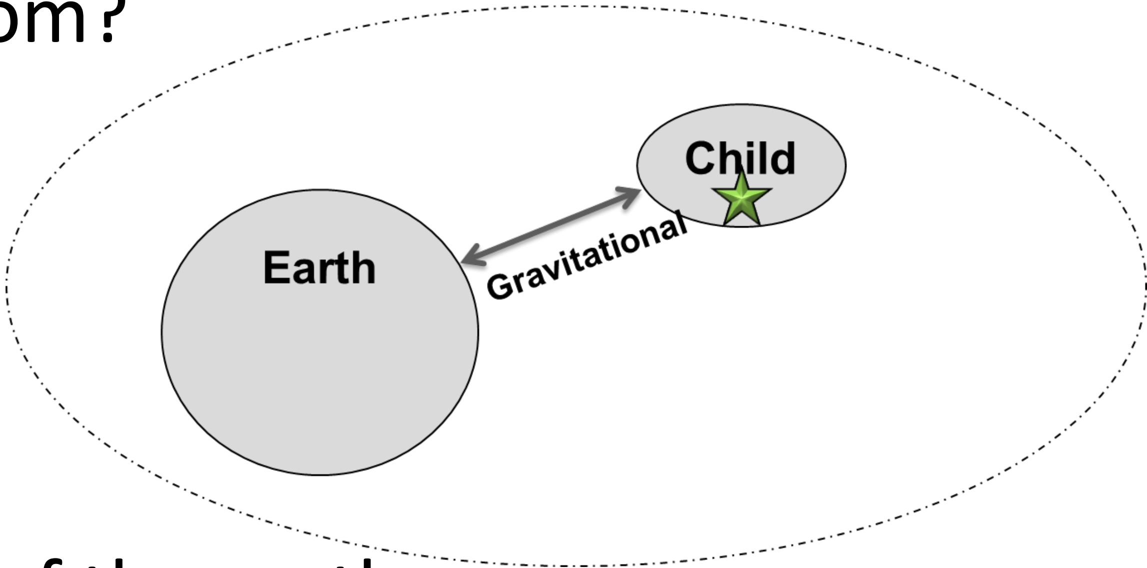
Foothold Principle: Potential Energy



Potential energy:

- Internal energy of a System
- Related to interactions (forces) within the System
- Can turn into kinetic energy (or other energy) when the objects in the system move

Where does kinetic energy of the child come from?



A. Potential energy of the earth
B. Potential energy of the child
C. Another source
D. Potential energy between the earth & child
E. Something else

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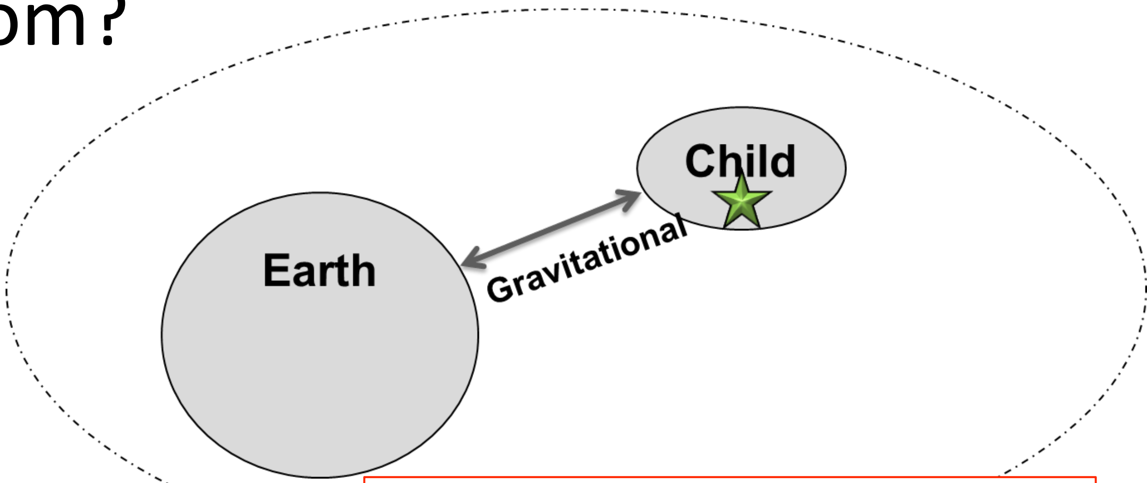

The potential energy is defined as the energy stored in the interaction between two objects.

A. Potential energy of the eart
B. Potential energy of the chilc
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Foothold ideas: Potential Energy

- For some forces between objects (gravity, springs) the work only depends on the change in relative position of the objects. Such forces are called *conservative*.
- For these forces the work done by them can be written

$$\vec{F} \cdot \Delta\vec{r}_{rel} = -\Delta U$$

- *U* is called a *potential energy* and can be considered an *energy of place belonging to the two objects that can be exchanged with KE.*

Foothold ideas: Potential Energy

- For some forces work only depends on the change in position. Then the work done can be written $$\vec{F} \cdot \Delta\vec{r} = -\Delta U$$

  U is called a *potential energy*.

- For gravity, $U_{gravity} = mgh$

  For a spring, $U_{spring} = \frac{1}{2} kx^2$

Dimensions and Units of Energy

- 1 $kg\text{-}m^2/s^2$ = 1 N-m = 1 Joule
- Other units of energy are common (and will be discussed later)
  - Calorie
  - eV (electron Volt)
  - erg (=1 $g\text{-}cm^2/s^2$)

Foothold ideas:
Conservation of Mechanical Energy

- Mechanical energy
  - The mechanical energy of a system of objects is conserved if resistive forces can be ignored.

$$\Delta\left(KE + PE\right) = 0$$

$$KE_{initial} + PE_{initial} = KE_{final} + PE_{final}$$

A spring-loaded toy dart gun is used to shoot a dart straight up in the air. The dart reaches a maximum height of 24 m. The same dart is shot straight up a second time from the same gun, but this time the spring is compressed only half as far before firing. How far up does the dart go this time, neglecting friction and air resistance and assuming an ideal spring?

A. 48 m
B. 24 m
C. 12 m
D. 6 m
E. Something else

Using Mechanical Energy Conservation

- If resistive forces can be ignored, mechanical energy is conserved
(exchanges with hidden internal energy such as thermal or chemical can be ignored)

$$KE_i + PE_i = KE_f + PE_f$$

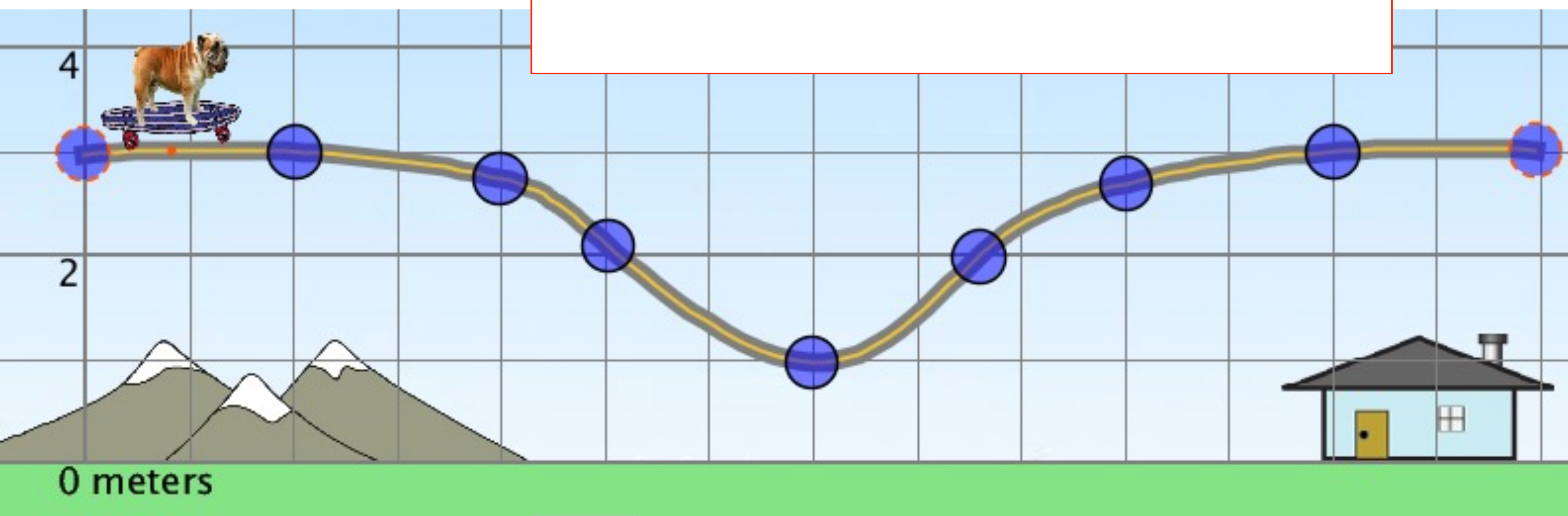
- *KE* may refer to one or more objects
PE may refer to one or more interactions.
- If only one object's KE is important and only one interaction matters, this can make things really easy.

A bulldog on a skateboard is moving very slowly when he encounters a 2 m dip. How fast will be be going when he is at the bottom of the dip? The bulldog and skateboard combined have a mass of 20 kg.

Friction and air drag

A. Very slowly
B. About 2 m/s

These problems all come the PhET simulation:
“Energy Skatepark”
https://phet.colorado.edu/en/simulation/energy-skate-park



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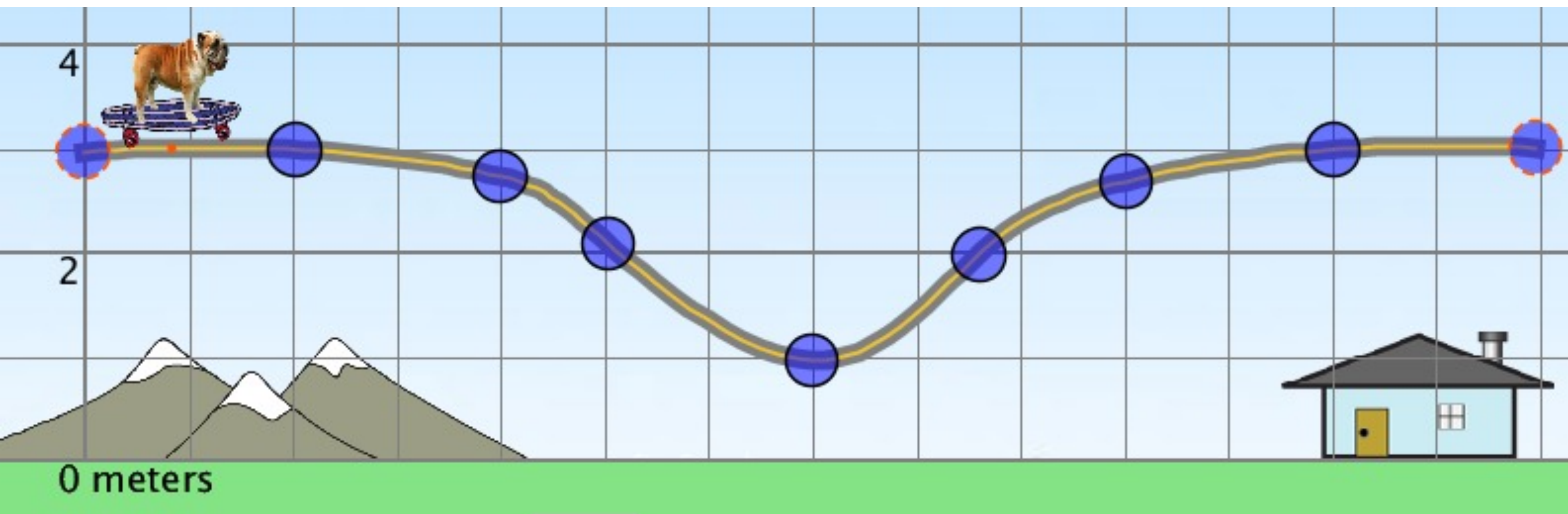
D. You can’t tell from the information given.



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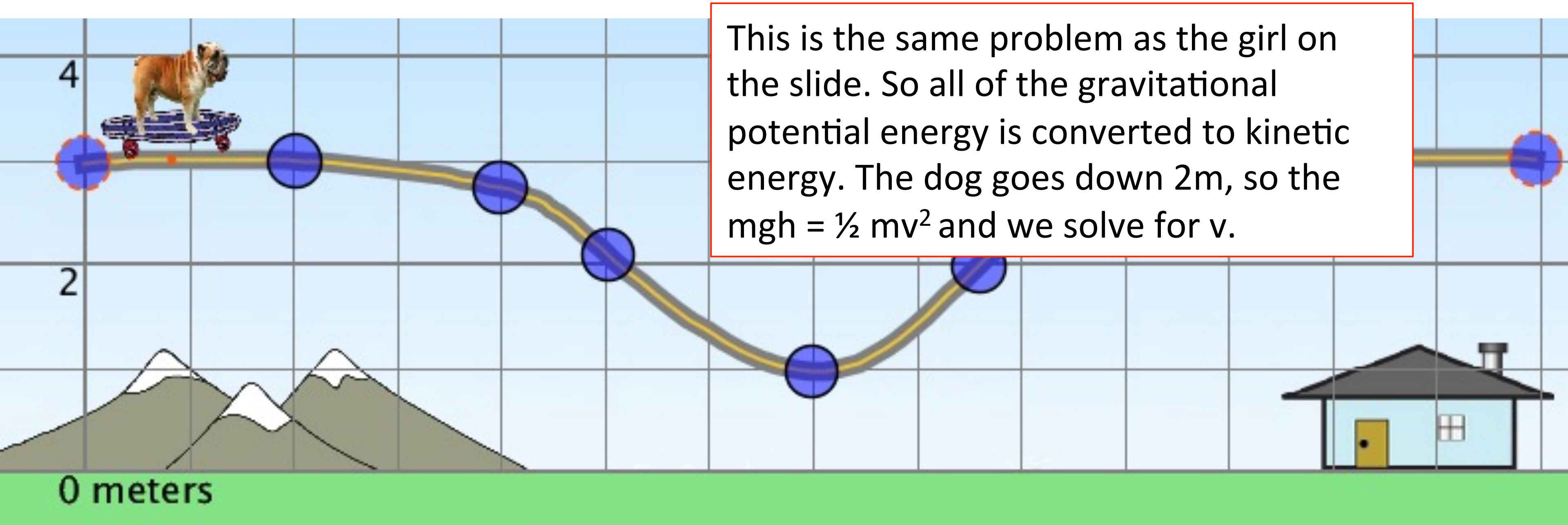
This is the same problem as the girl on the slide. So all of the gravitational potential energy is converted to kinetic energy. The dog goes down 2m, so the $mgh = ½ mv^2$ and we solve for v.



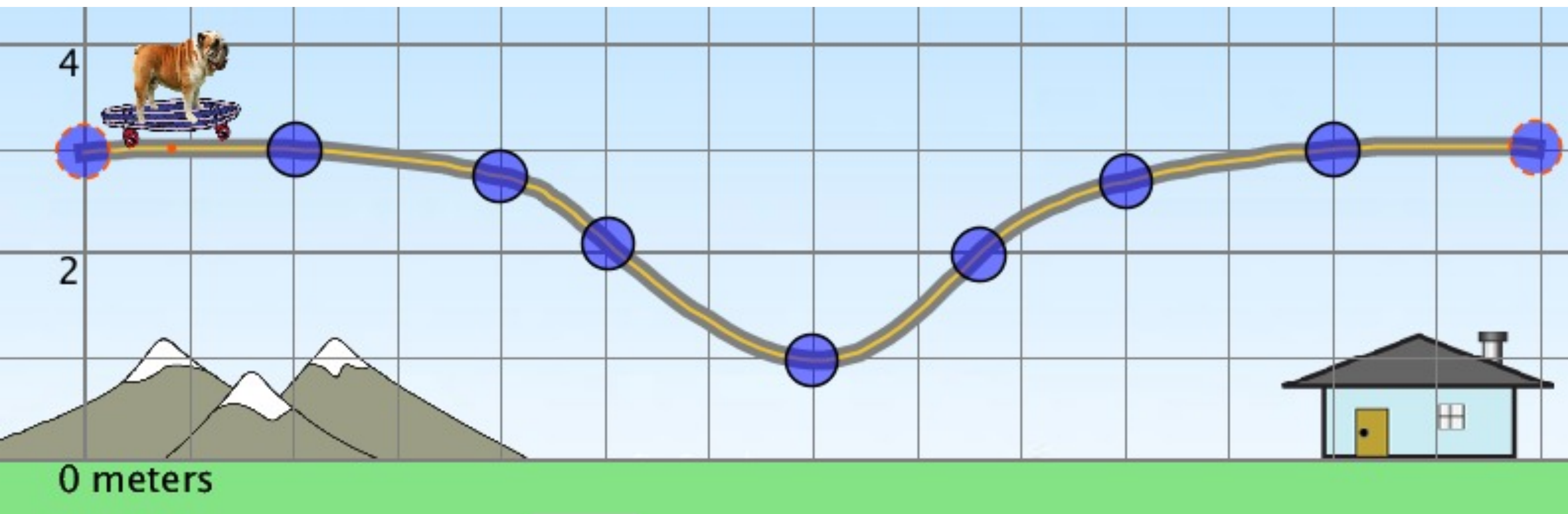
A bulldog on a skateboard is moving very slowly when he encounters a 2 m dip. The bulldog and skateboard combined have a mass of 20 kg. What is their total mechanical energy?

A. Almost zero

B. About 200 Joules

C. About 600 Joules

D. You can’t tell from the information given.



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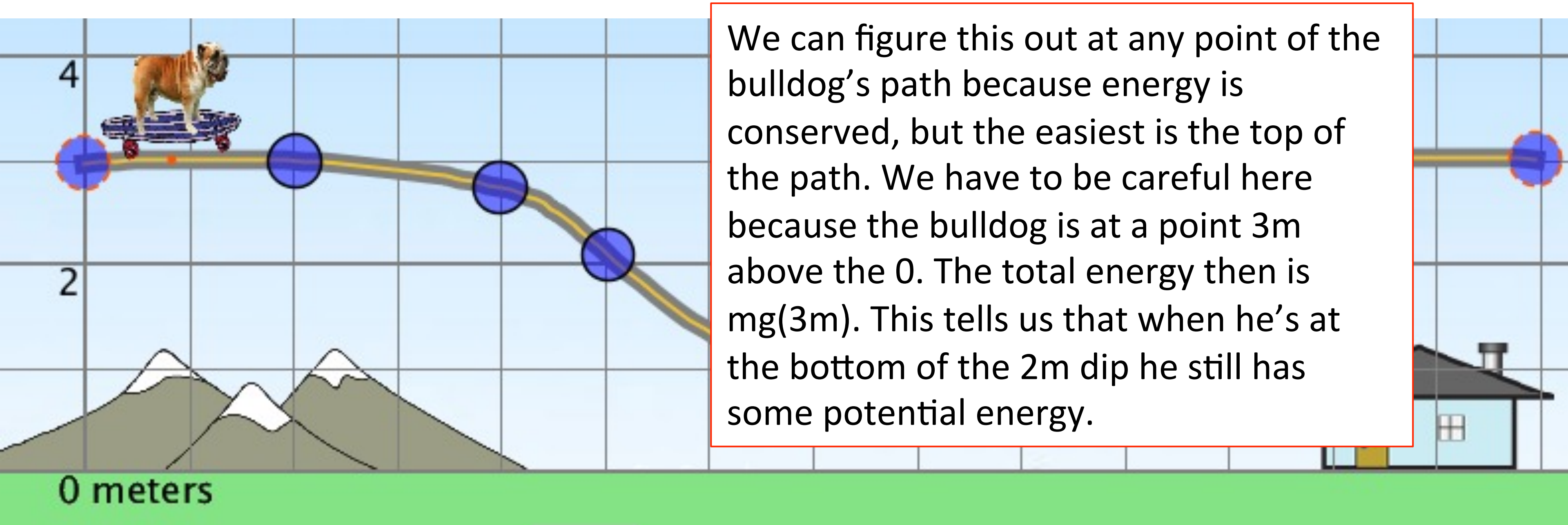
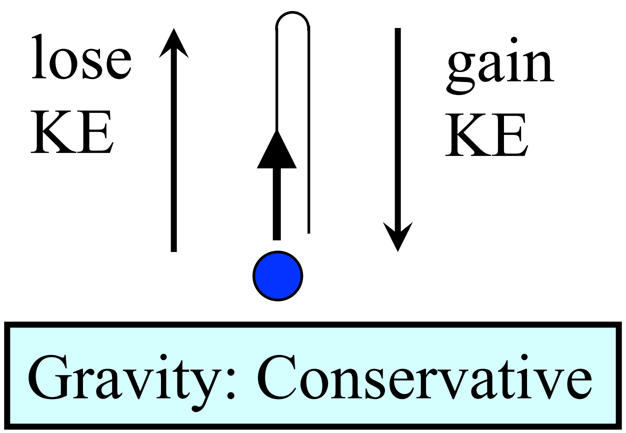
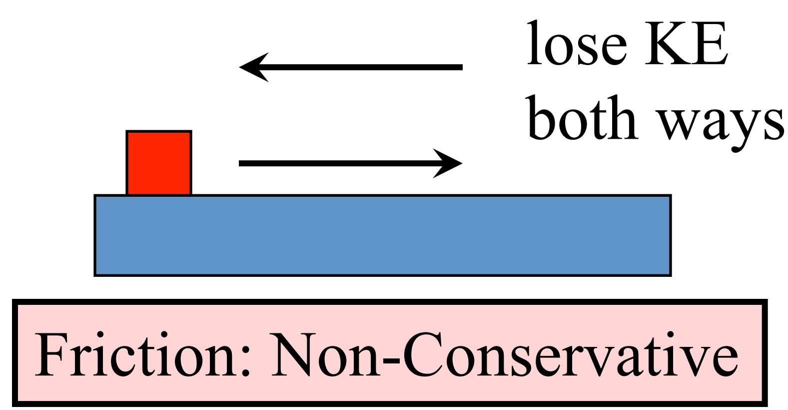


We can figure this out at any point of the bulldog's path because energy is conserved, but the easiest is the top of the path. We have to be careful here because the bulldog is at a point 3m above the 0. The total energy then is mg(3m). This tells us that when he's at the bottom of the 2m dip he still has some potential energy.

Conservative forces

- Forces (like gravity or springs) are conservative if when the force takes KE away, you can get it back when you go back to where you started.
- If the kinetic energy that a force takes away <u>can't</u> be restored by going back to where you started it is called non-conservative.
- Compare gravity and friction:





Inelastic collisions

When two objects collide and stick together some energy is lost to the surroundings

Kinetic energy is not conserved

$$KE_{initial} = KE_{final} + Thermal$$