Potential / Kinetic / Mechanical Energy

1) $KE = \frac{1}{2} m v^2$

$KE = \frac{1}{2} (0.150) (5^2)$

<u>$KE = 1.875$ J</u>

2) a)

$$\frac{15 \text{ km}}{1 \text{ h}} = \frac{15000\text{m}}{3600\text{s}} = 4.17 \frac{\text{m}}{\text{s}}$$

b) $KE = \frac{1}{2} m v^2$

$KE = \frac{1}{2} (5) (4.17^2)$

<u>$KE = 43.47$ J</u>

3) $PE = m g h$

$PE = (0.5)(9.8)(0.3)$

<u>$PE = 1.47$ J</u>

4) a) $PE = m\ g\ h$

$PE = (60)(9.8)(54)$ ← *8^{th} floor*

<u>$PE = 31752$ J</u>

b) Each floor = $\frac{54m}{8}$ = 6.75m per floor

$PE = m\ g\ h$

$PE = (60)(9.8)(6 \bullet 6.75)$

<u>$PE = 23814$ J</u>

c) Position/Height & Mass

5) $KE = \frac{1}{2} m v^2$

$57 = \frac{1}{2} (0.135) (v^2)$

$57 = 0.0675 (v^2)$

$844.44 = v^2$

$\sqrt{844.44} = v$

$\underline{\sim 29 m/s = v}$

6) $PE = m g h$

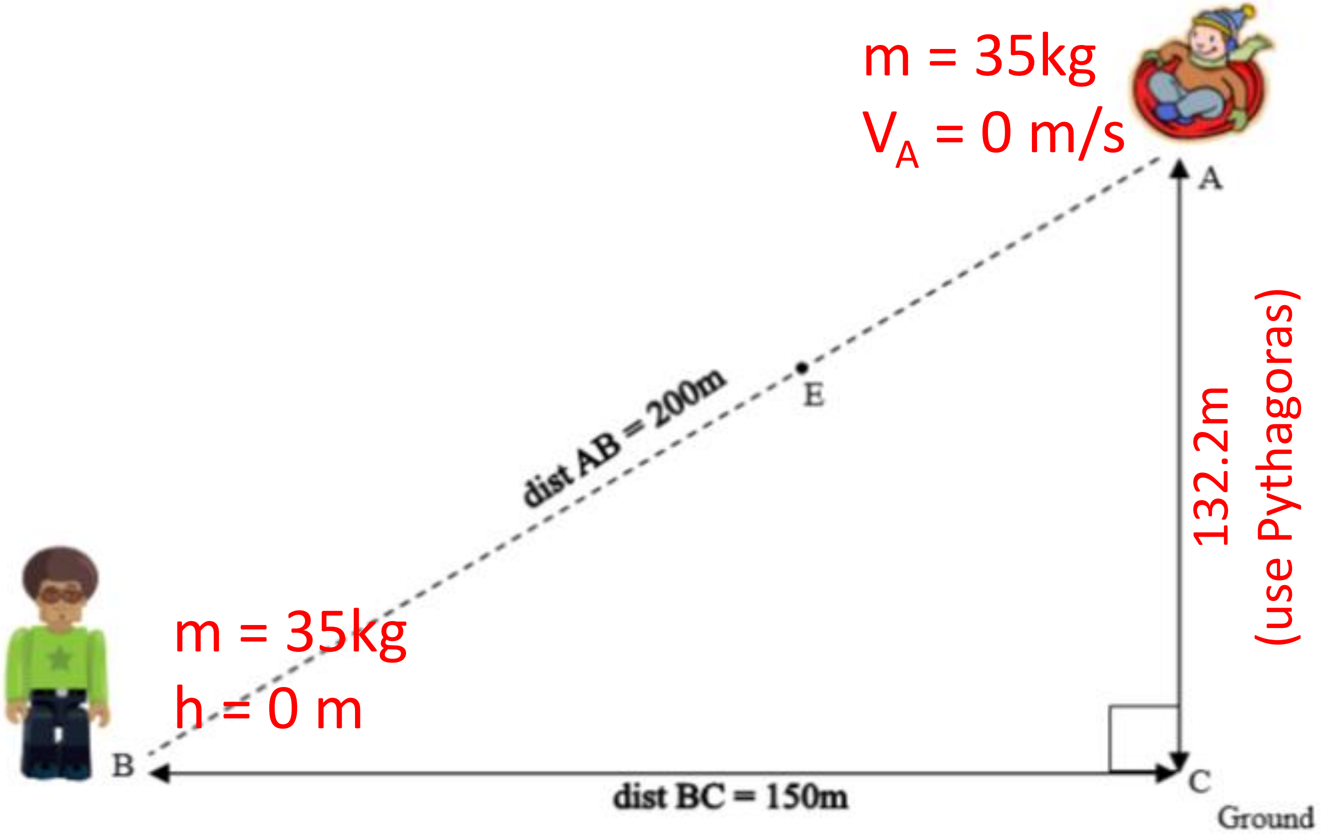
$28.16 = (2.2)(g)(8)$

$\underline{g = 1.6 \ m/s^2}$

Gravity of moon

7) A 35kg child toboggans down a slope. Beginning fi
a standstill (point A) the child travels towards
their parent which is located 200meters away.

a) What is the kinetic Energy at A
b) What is the potential Energy at A relative to the ground
c) What is the potential energy at B relative to the ground
d) What is the total mechanical energy at A (prove mathematically
e) What is the total mechanical energy at B (prove mathematically
f) What is the total mechanical energy at E
g) What is the velocity of the child at point B
h) What is the kinetic energy at B



a) $KE_A = \frac{1}{2} m v^2$

$KE_A = \frac{1}{2} (35)(0^2)$

$\underline{KE_A = 0 \text{ J}}$ *(V=0m/s)*

b) $PE_A = m g h$

$PE_A = 35(9.8)(132.2)$

$\underline{PE_A = 45345 \text{ J}}$

c) $PE_B = m g h$

$PE_B = 35 (9.8) (0)$

$\underline{PE_B = 0 \text{ J}}$ *(h=0m)*

7) A 35kg child toboggans down a slope. Beginning fi
a standstill (point A) the child travels towards
their parent which is located 200meters away.

a) What is the kinetic Energy at A
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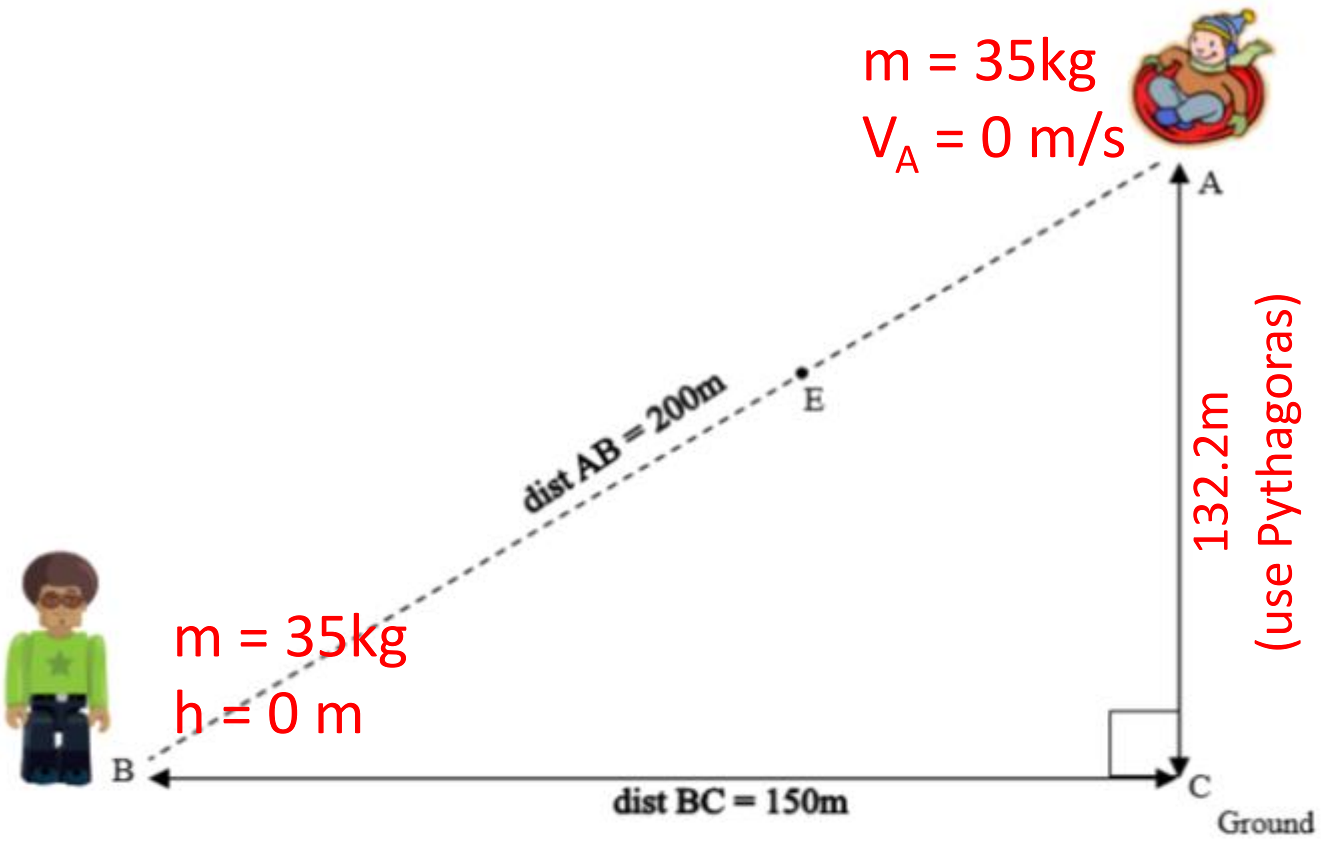
g) What is the velocity of the child at point B
h) What is the kinetic energy at B



d) $ME_A = KE_A + PE_A$

$ME_A = 0 + 45345$

$\underline{ME_A = 45345\ J}$

constant

e) $\underline{ME_B = 45345\ J}$

constant

f) $\underline{ME_E = 45345\ J}$

constant

g) $ME_B = KE_B + PE_B$

$$45345 = \frac{1}{2} m v^2 + m g h$$

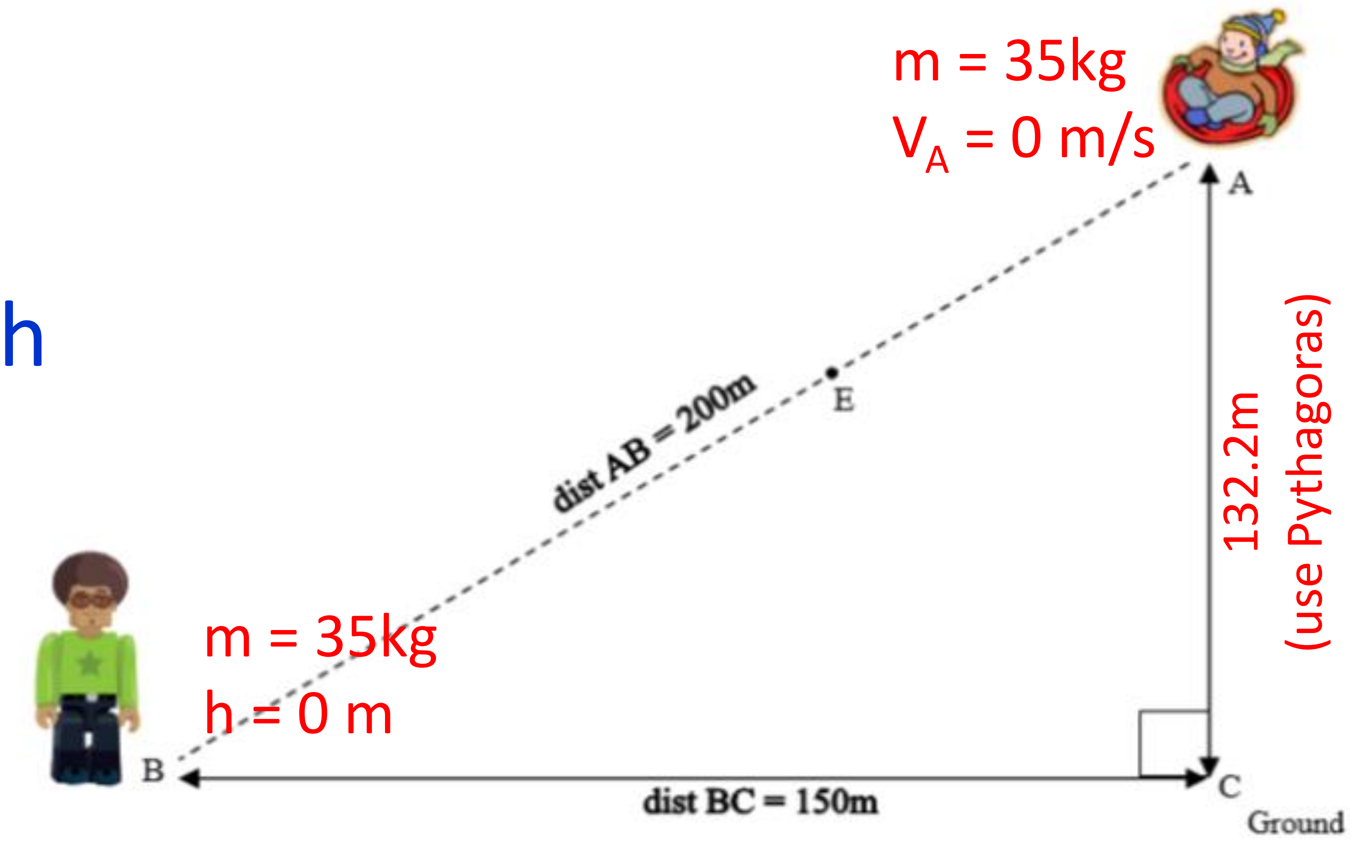
$$45345 = \frac{1}{2} (35) v^2 + 0$$

$$45345 = (17.5) v^2$$

$$2591.14 = v^2$$

$$\sqrt{2591.14} = v$$

$\underline{50.9 \text{ m/s} = v}$

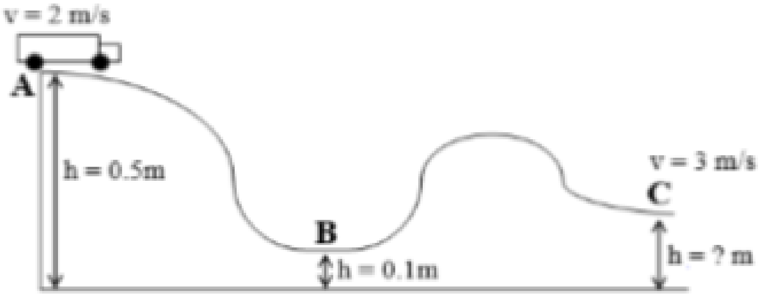


h) $KE_B = \frac{1}{2} m v^2$

$$KE_B = \frac{1}{2} (35) (50.9^2)$$

$\underline{KE_B = 45345 \text{ J}}$

8) Sophie builds a toy road for her little brother to play with as shown below. Her little brother places a toy school bus with a mass of 0.5kg at point A and pushes it with a velocity of 2m/s. The toy bus travels the entire length of the road (frictional force can be neglected).



	KE	PE	ME
Point A	$KE_A = ½\ m\ v^2$ $KE_A = ½\ (0.5)\ (2^2)$ $KE_A = 1$ J	$PE_A = m\ g\ h$ $PE_A = (0.5)\ (9.8)\ (0.5)$ $PE_A = 2.45$ J	$ME_A = KE_A + PE_A$ $ME_A = 1 + 2.45$ $ME_A = 3.45$ J *(const)*
Point B	$ME_B = KE_B + PE_B$ $3.45 = KE_B + 0.49$ $KE_B = 2.96$ J	$PE_B = m\ g\ h$ $PE_B = (0.5)\ (9.8)\ (0.1)$ $PE_B = 0.49$ J	$ME_B = 3.45$ J *(const)*
Point C	$KE_C = ½\ m\ v^2$ $KE_C = ½\ (0.5)\ (3^2)$ $KE_C = 2.25$ J	$ME_C = KE_C + PE_C$ $3.45 = 2.25 + PE_C$ $PE_C = 1.2$ J	$ME_C = 3.45$ J *(const)*

8 b) Height at point C

$ME_C = KE_C + PE_C$

$3.45 = 2.25 + PE_C$

$PE_C = 1.2\ J$

$PE_C = m\ g\ h$

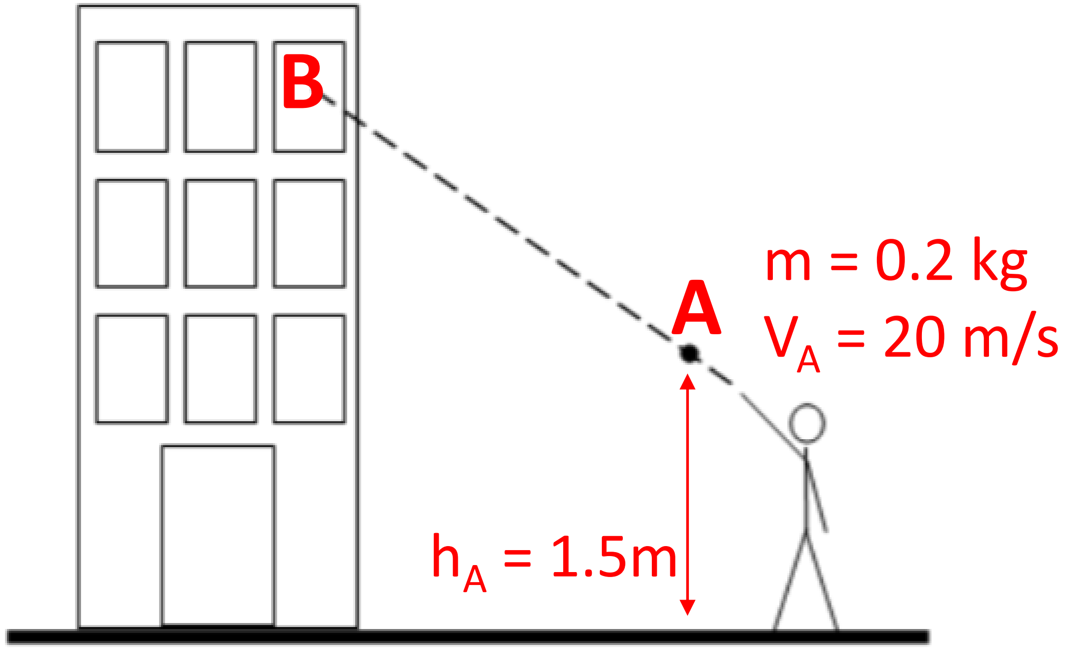
$1.2 = (0.5)\ (9.8)\ h$

$$\frac{1.2}{(0.5)(9.8)} = h$$

$\underline{0.245m = h}$

9) A bad boy throws a 0.2kg rock at a building window. At the instant the rock leaves the boy's hand, it is moving at 20m/s and is located 1.5m above the ground.

a) Find the total Mechanical energy of the rock,
b) How high above the ground does the rock strike the building's window if it is moving at 10m/s at the moment when it hits it.



a) $ME_A = KE_A + PE_A$

$ME_A = \frac{1}{2} m v^2 + mgh$

$ME_A = \frac{1}{2}(0.2)(20^2) + 0.2(9.8)(1.5)$

$ME_A = 40 + 2.94$

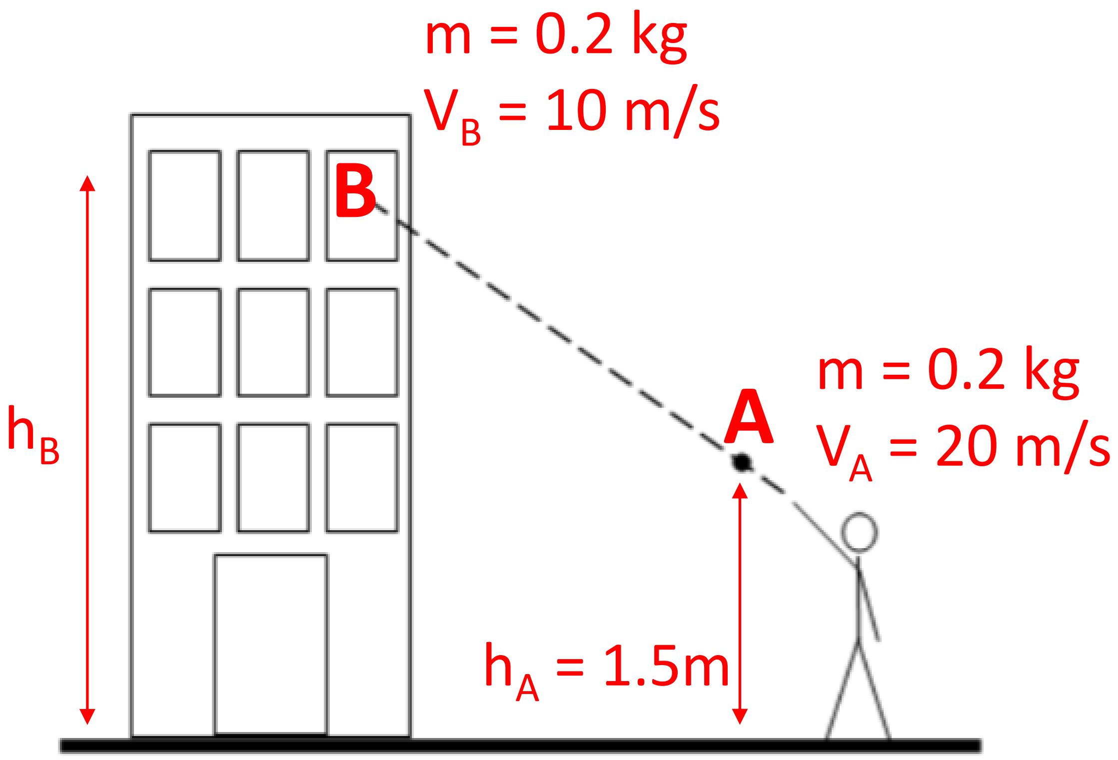
$\underline{ME_A = 42.94 \text{ J}}$

constant

9) A bad boy throws a 0.2kg rock at a building window. At the instant the rock leaves the boy's hand, it is moving at 20m/s and is located 1.5m above the ground.

a) Find the total Mechanical energy of the rock,

b) How high above the ground does the rock strike the building's window if it is moving at 10m/s at the moment when it hits it.



b) $ME_B = 42.94$ *constant*

b) $ME_B = KE_B + PE_B$

$42.94 = \frac{1}{2} m v^2 + m g h$

$42.94 = \frac{1}{2}(0.2)(10^2) + 0.2(9.8)h$

$42.94 = 10 + 1.96h$

$32.94 = 1.96h$

$\underline{16.8\text{m} = h}$

① $PE = mgh$

$PE = 60(9.8)(0)$

$PE = 0\ J$

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

$KE = \frac{1}{2}(60)(8^2)$

$KE = 1920\ J$

$ME = KE + PE$

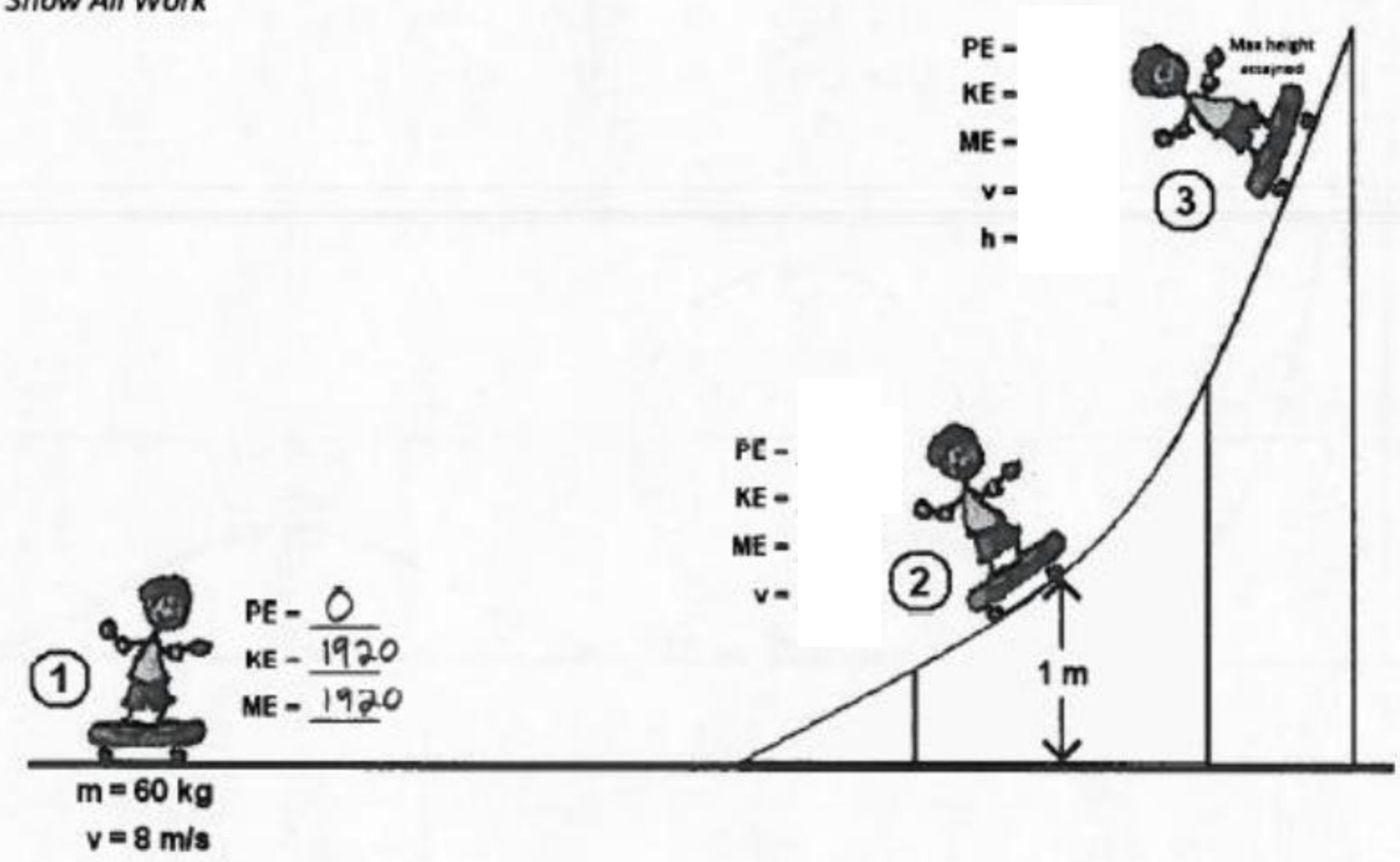
$ME = 1920 + 0$

$ME = 1920\ J$

(Const)

10). Calculate the potential energy, kinetic energy, mechanical energy, velocity, and height of the skater at the various locations.

Show All Work



(2) $PE = mgh$

$PE = 60(9.8)(1)$

$PE = 588\,J$

$ME = 1920\,J$ (const)

$ME = KE + PE$

$1920 = KE + 588$

$KE = 1332\,J$

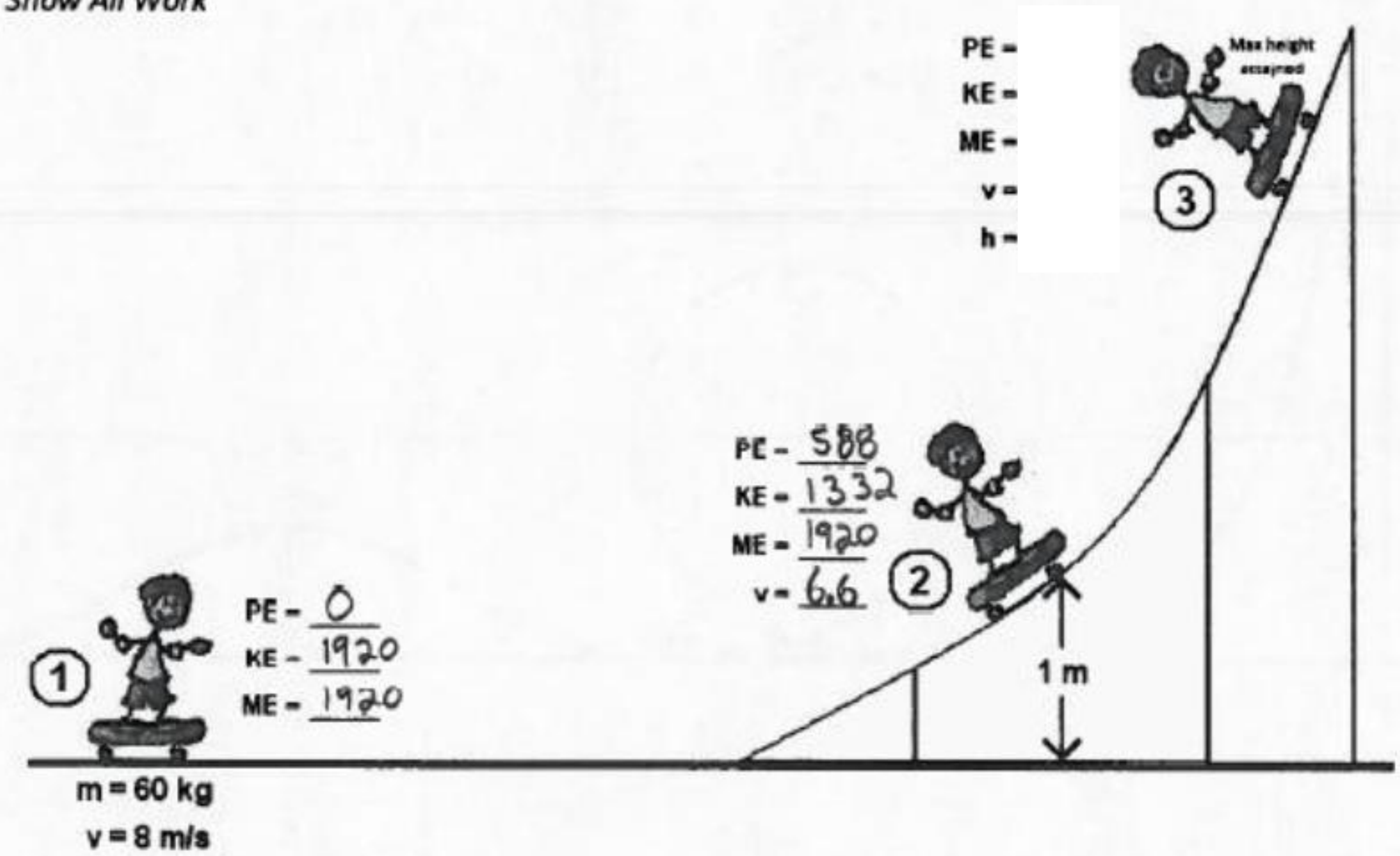
$KE = \frac{1}{2}mv^2$

$1332 = \frac{1}{2}(60)v^2$

$6.6\,m/s = v$

10). Calculate the potential energy, kinetic energy, mechanical energy, velocity, and height of the skater at the various locations.

Show All Work



③ At max height, $v = 0\,m/s$

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

$KE = \frac{1}{2}(60)(0^2)$

$KE = 0\,J$

$ME = 1920\,J$ (const)

$ME = KE + PE$

$1920 = 0 + PE$

$PE = 1920\,J$

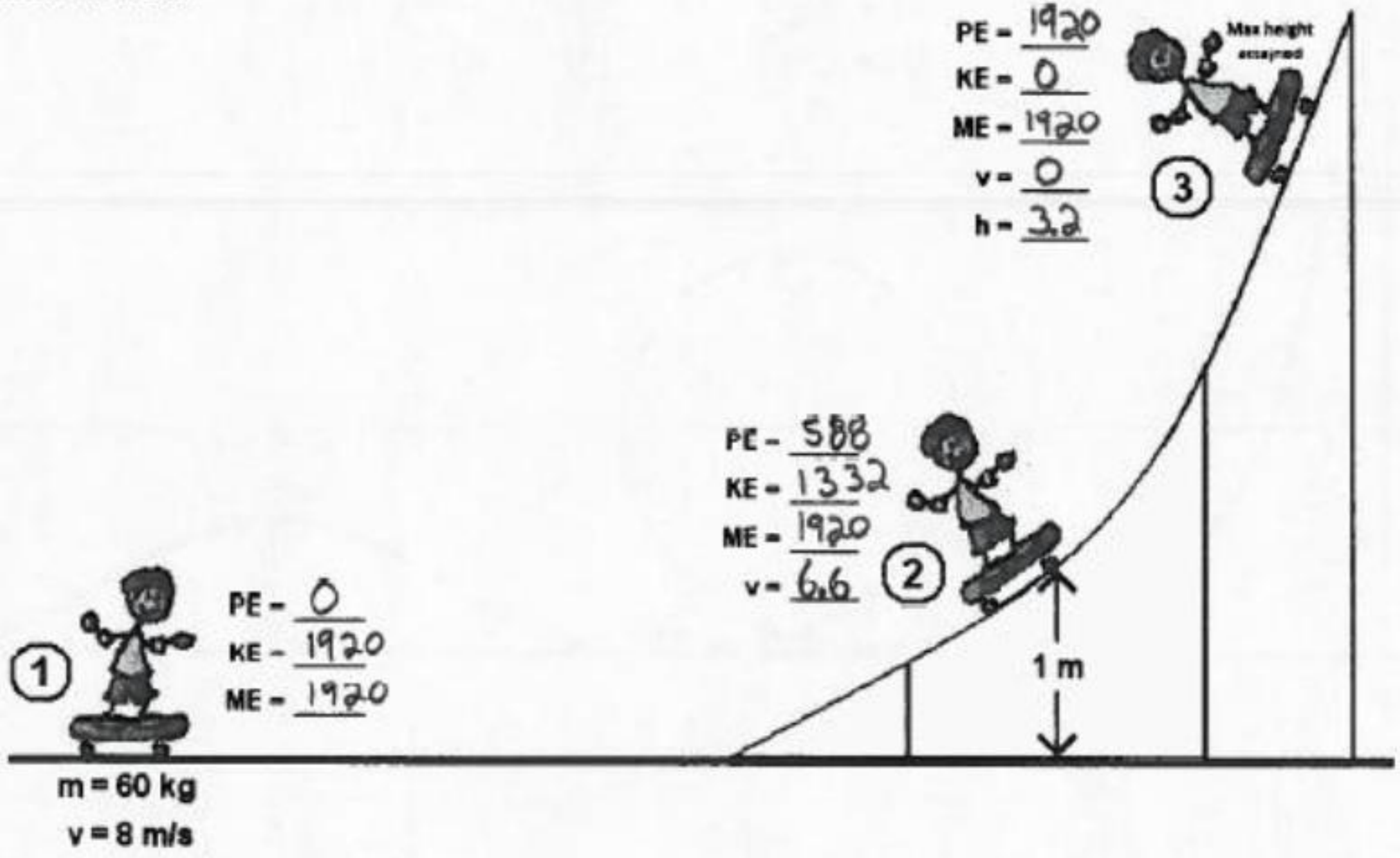
$PE = mgh$

$1920 = 60(9.8)h$

$3.2m = h$

Calculate the potential energy, kinetic energy, mechanical energy, velocity, and height of the skater at the various locations.

Show All Work



①

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

$KE = \frac{1}{2}(50)(0^2)$

$KE = 0\ J$

$PE = mgh$

$PE = 50(9.8)(4)$

$PE = 1960\ J$

$ME = KE + PE$

$ME = 0 + 1960$

$ME = 1960\ J$

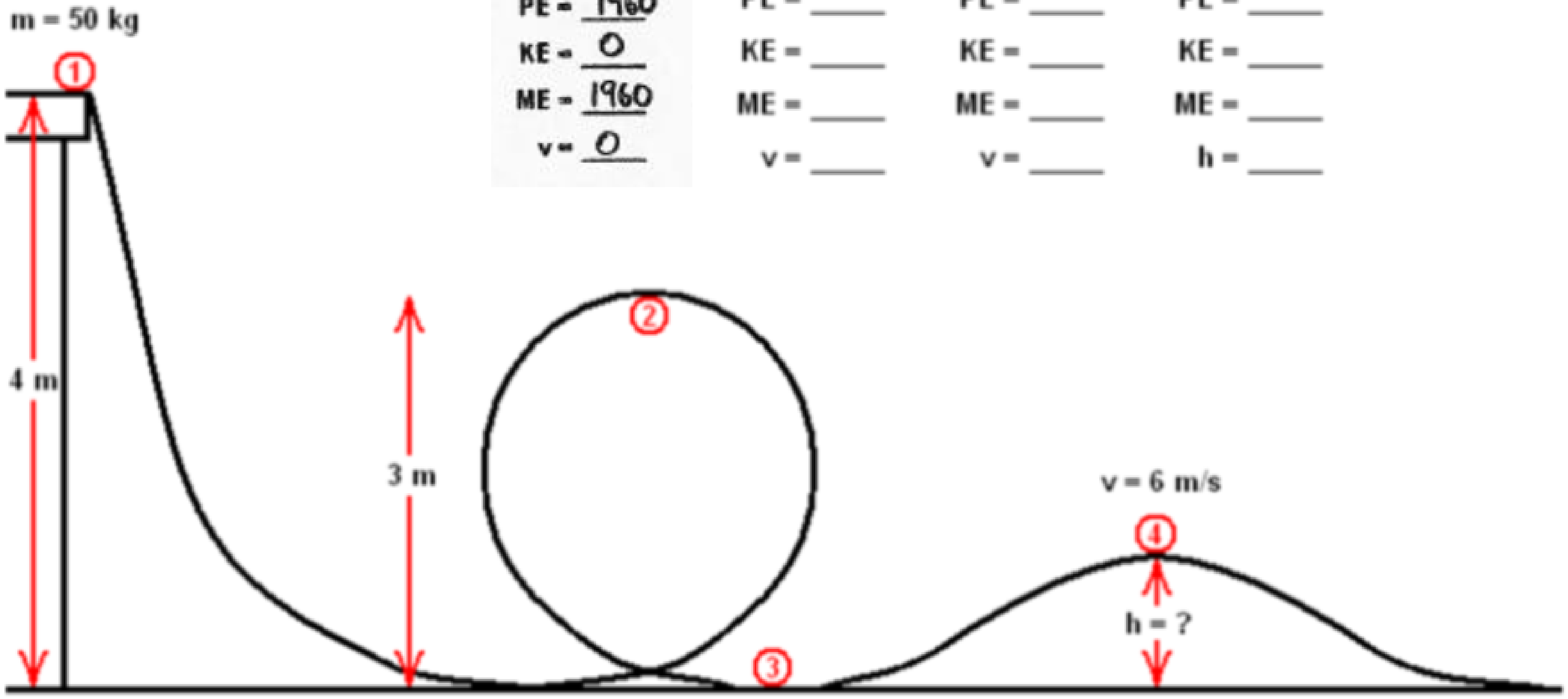
(const)

$V = 0\ m/s$

11. Calculate the potential energy, kinetic energy, mechanical energy, velocity, and height of the ball at the various locations. The ball is initially at a standstill.

Show All Work

①	②	③	④
PE = 1960	PE = ____	PE = ____	PE = ____
KE = 0	KE = ____	KE = ____	KE = ____
ME = 1960	ME = ____	ME = ____	ME = ____
v = 0	v = ____	v = ____	h = ____



(2)

$PE = mgh$

$PE = 50(9.8)(3)$

$PE = 1470$

$ME = 1960\ J$

(const)

$ME = KE + PE$

$1960 = KE + 1470$

$KE = 490\ J$

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

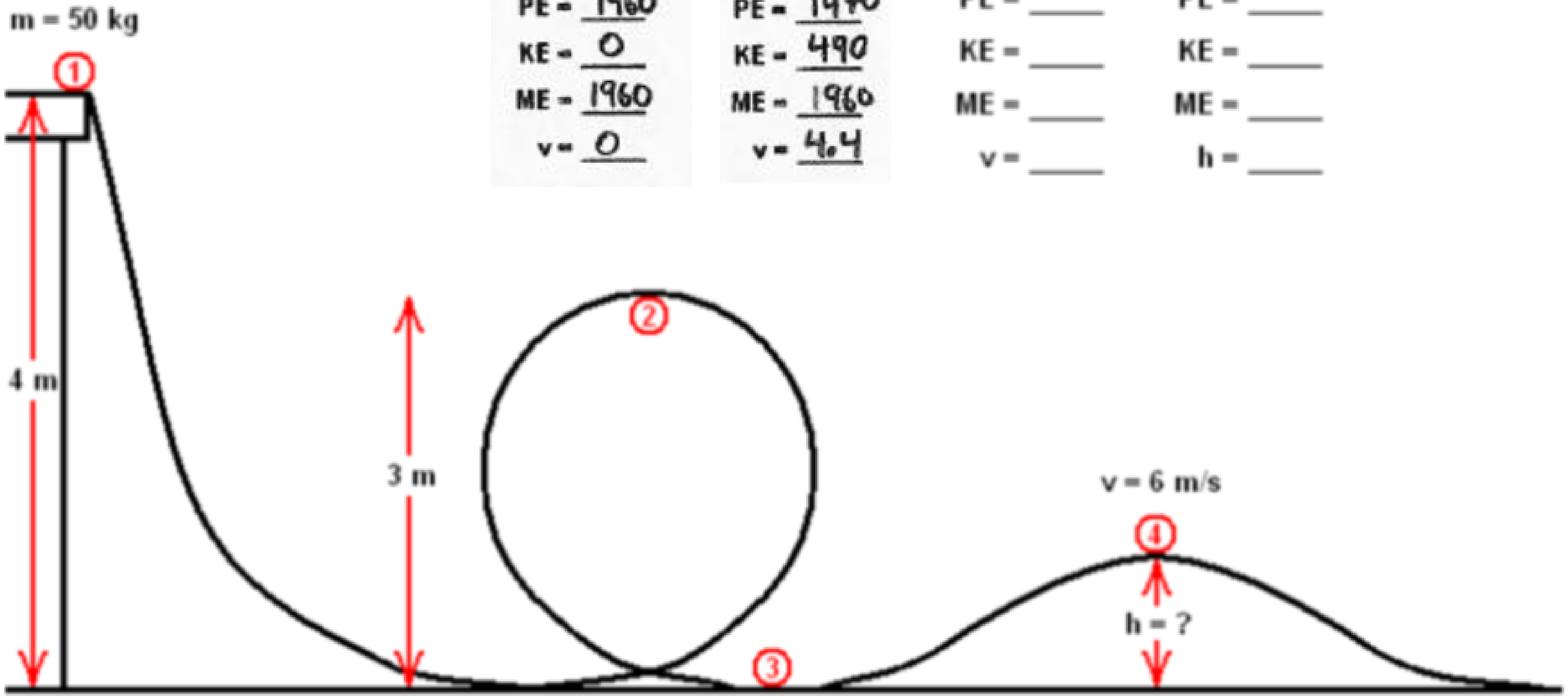
$490 = \frac{1}{2}(50)v^2$

$4.4\ m/s = V$

11. Calculate the potential energy, kinetic energy, mechanical energy, velocity, and height of the ball at the various locations. The ball is initially at a standstill.

Show All Work

①	②	③	④
PE = 1960	PE = 1470	PE = ____	PE = ____
KE = 0	KE = 490	KE = ____	KE = ____
ME = 1960	ME = 1960	ME = ____	ME = ____
v = 0	v = 4.4	v = ____	h = ____



③

$PE = mgh$
$PE = 50(9.8)(0)$
$PE = 0\ J$

$ME = 1960\ J$
(const)

$ME = KE + PE$
$1960 = KE + 0$
$KE = 1960\ J$

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

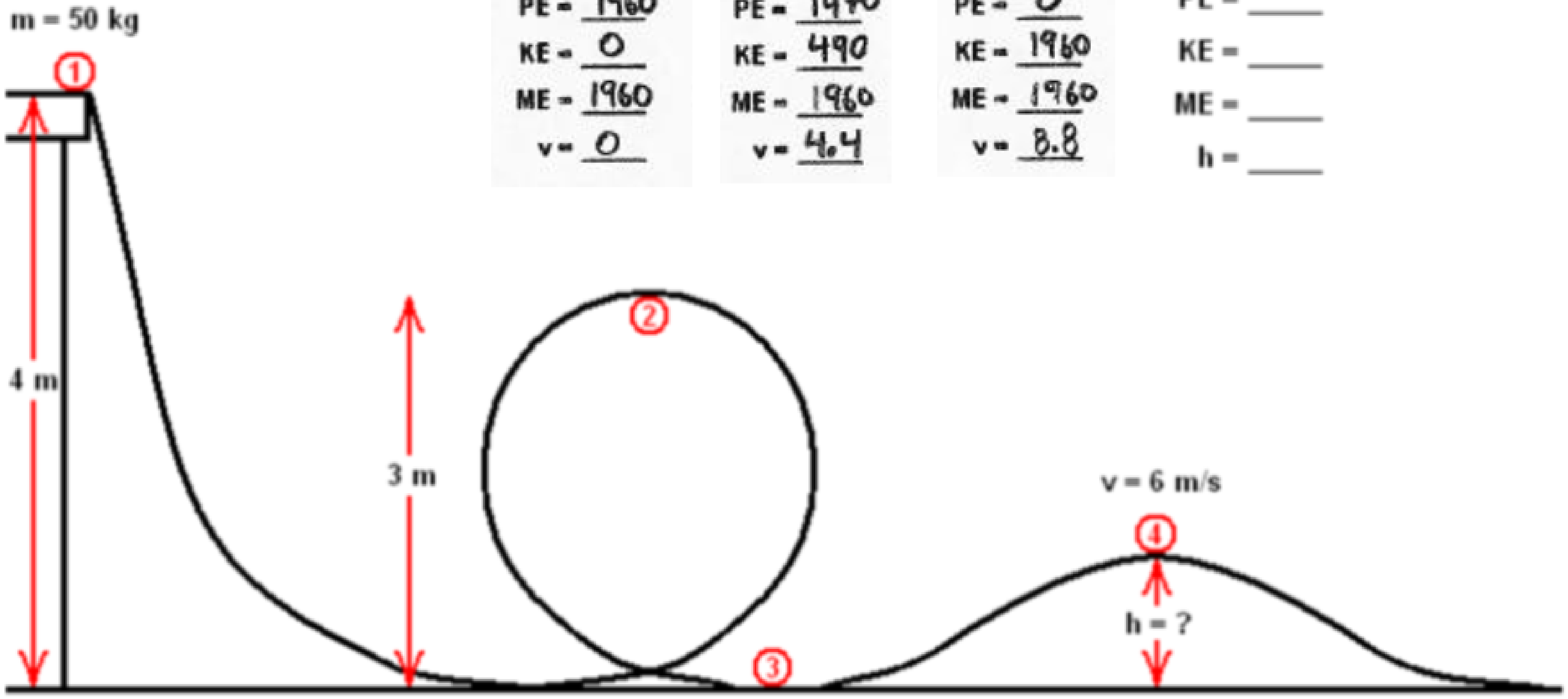
$1960 = \frac{1}{2}(50)v^2$

$8.8\ m/s = V$

11. Calculate the potential energy, kinetic energy, mechanical energy, velocity, and height of the ball at the various locations. The ball is initially at a standstill.

Show All Work

	①	②	③	④
PE =	1960	1470	0	____
KE =	0	490	1960	____
ME =	1960	1960	1960	____
v = / h =	0	4.4	8.8	h = ____



(4)

11. Calculate the potential energy, kinetic energy, mechanical energy, velocity, and height of the ball at the various locations. The ball is initially at a standstill.

Show All Work

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

$KE = \frac{1}{2}(50)(6^2)$

$KE = 900\ J$

$ME = 1960\ J$ (const)

$ME = KE + PE$

$1960 = 900 + PE$

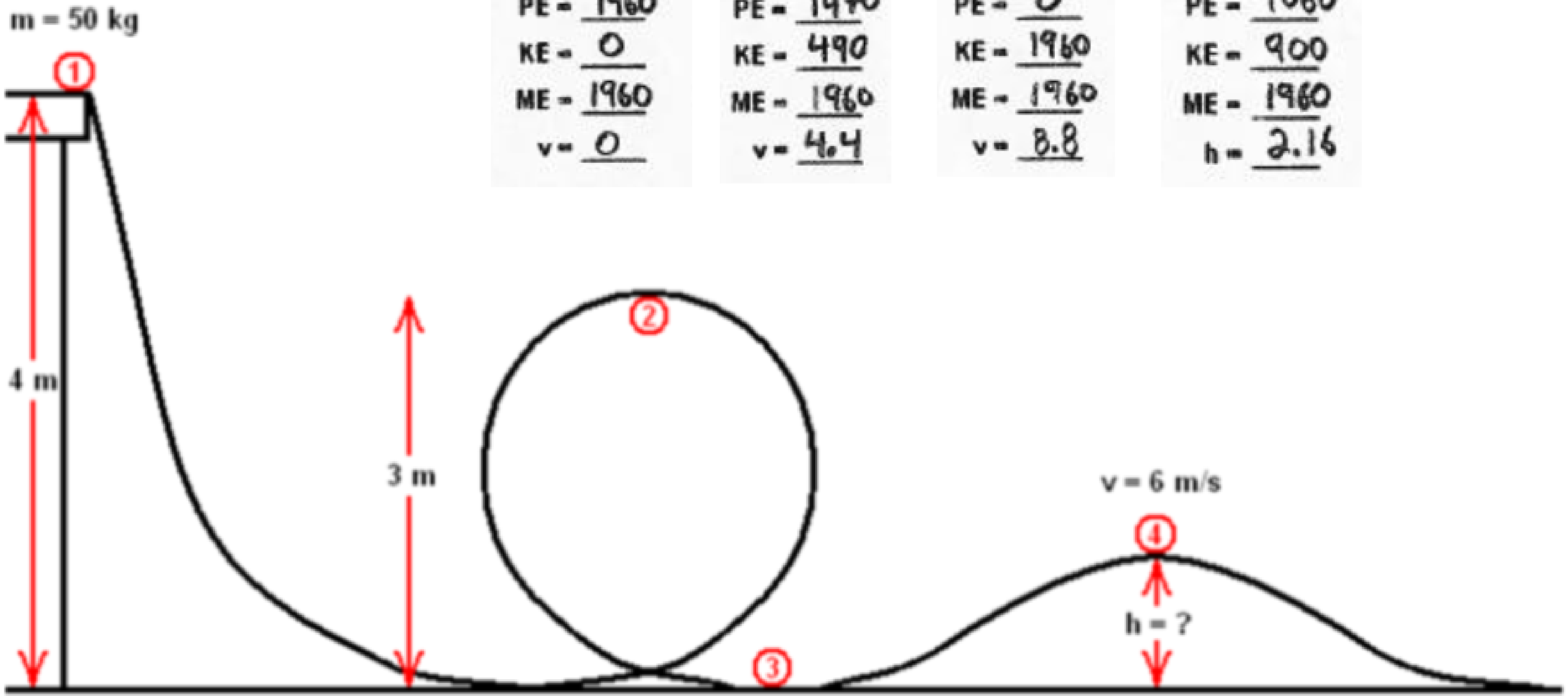
$PE = 1060\ J$

$PE = mgh$

$1060 = 50(9.8)h$

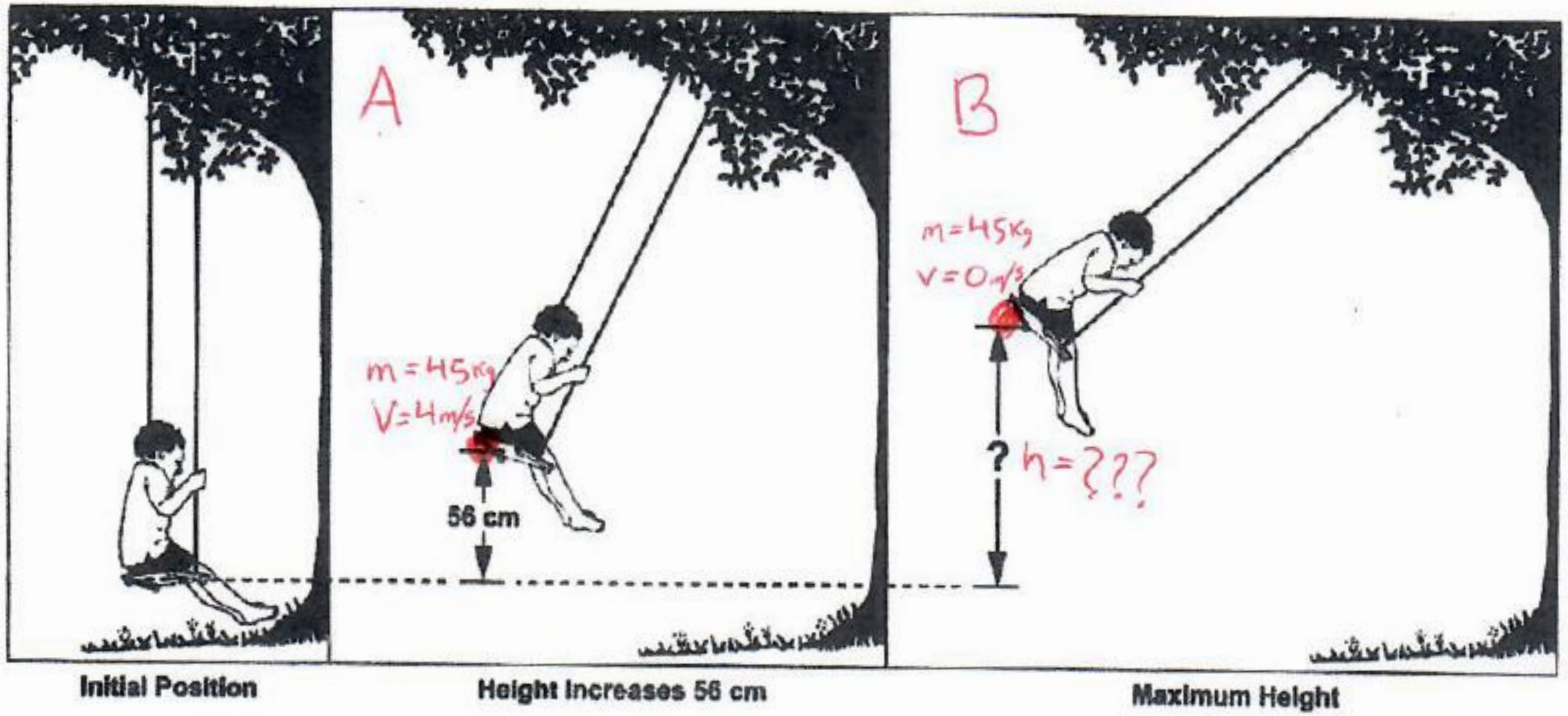
$2.16m = h$

	①	②	③	④
PE	1960	1470	0	1060
KE	0	490	1960	900
ME	1960	1960	1960	1960
v / h	v = 0	v = 4.4	v = 8.8	h = 2.16



Potential / Kinetic / Mechanical Energy Additional Harder Problems

1) At the playground, Joseph is swinging on a wooden swing. When the height of the swing rose to 56 cm above the initial position, Joseph's velocity was 4.0 m/s. His mass is 45 kg.



What is the maximum height above the initial position that Joseph will reach?
Assume there is no friction.

① $KE_A = \frac{1}{2}mv^2$

$KE_A = \frac{1}{2}(45)(4^2)$

$KE_A = 360\text{ J}$

② $PE_A = mgh$

$PE_A = 45(9.8)(0.56)$

$PE_A = 247\text{ J}$

③ $ME_A = KE_A + PE_A$

$ME_A = 360 + 247$

$ME_A = 607\text{ J}$

const

④ $ME_B = 607\text{ J}$

(const)

⑤ $KE_B = \frac{1}{2}mv^2$

$KE_B = \frac{1}{2}m(0^2)$

$KE_B = 0\text{ J}$

⑥ $ME_B = KE_B + PE_B$

$607 = 0 + mgh$

$607 = 0 + 45(9.8)h$

$607 = 441 \cdot h$

$h = 1.38\text{ m}$

2) After a heavy snowstorm, Romina must clear the snow from the roof of her shed which is 2.5 m above the ground. She pushes the snow off the roof using 61.8 J of energy.

The snow which has a mass of 5.0 kg falls on her miniature greenhouse. The top of the greenhouse is 0.5 m above the ground.

The situation is illustrated.

What is the speed of the snow when it hits the top of the greenhouse?
(assume the snow moves as one big chunk)

① $KE_A = 61.8\text{ J}$

② $PE_A = mgh$
$PE_A = 5(9.8)(2.5)$
$PE_A = 122.5\text{ kJ}$

③ $ME_A = KE_A + PE_A$
$ME_A = 61.8 + 122.5$
$ME_A = 184.3\text{ J}$ (const)

④ $ME_B = 184.3\text{ kJ}$ (const)

⑤ $PE_B = mgh$
$PE_B = (5)(9.8)(0.5)$
$PE_B = 24.5\text{ J}$

⑥ $ME_B = KE_B + PE_B$
$184.3 = \frac{1}{2}mv^2 + 24.5$
$159.8 = \frac{1}{2}(5)v^2$
$63.92 = v^2$
$\sqrt{63.92} = v$
$v = 8\text{ m/s}$