Video Analysis: Iron Man's Hero Landing

Spring 2019 MET 213

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PURDUE UNIVERSITY | Polytechnic Institute

Video Analysis: Outline

Video Analysis: Iron Man Landing

1. Assignment Instructions
2. Scene/Scenario
3. Data Collection
4. Math/Results
5. What would really happen in real life?

[SCENE], [LANDING]

Video Analysis: 1. Assignment Instructions

Video Analysis: Iron Man Landing

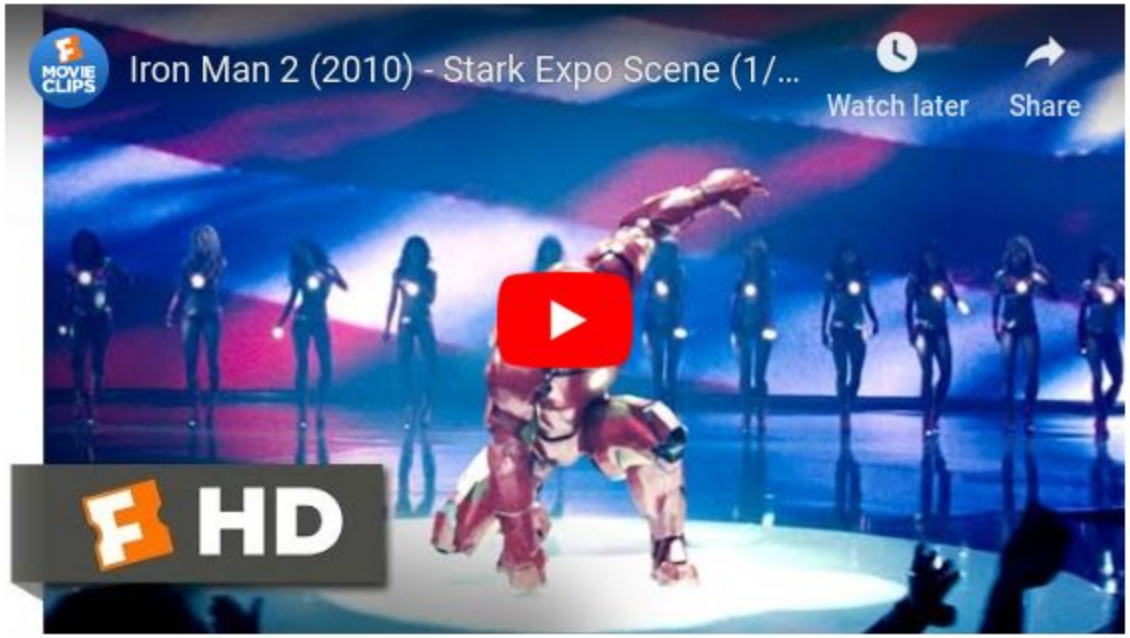
- **Find** a video online
- **Analyze** it
- Must be **related** to the class
- Apply **equations** from the class
- Based on **estimations** of quantities in the video

[HAND]

Video Analysis: 2. Scene/Scenario

Video Analysis: Iron Man Landing

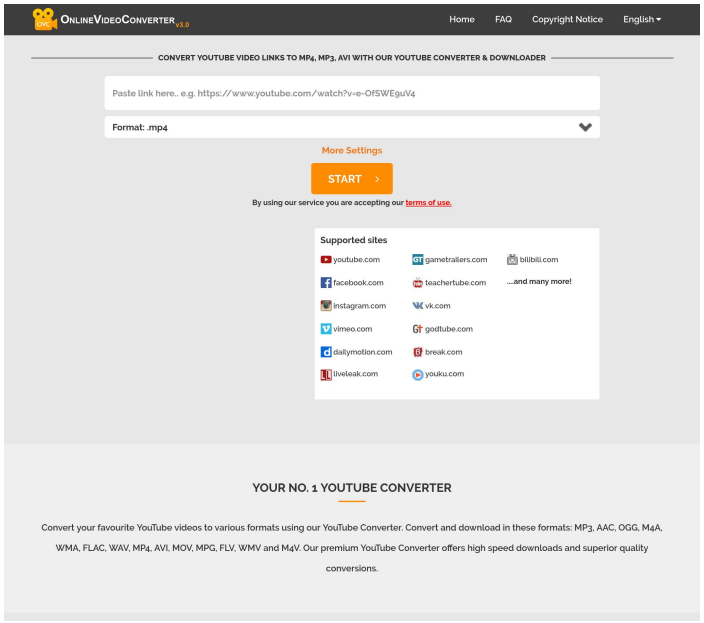
Iron Man 2 (2010) - Stark Expo Scene



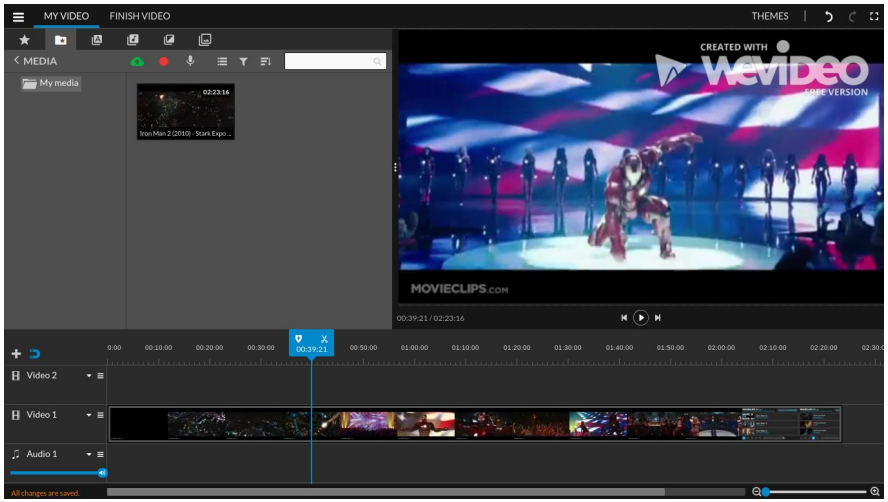
Video Analysis: 3. Data Collection

Video Analysis: Iron Man Landing

Downloaded Video:
YouTube Converter & Downloader

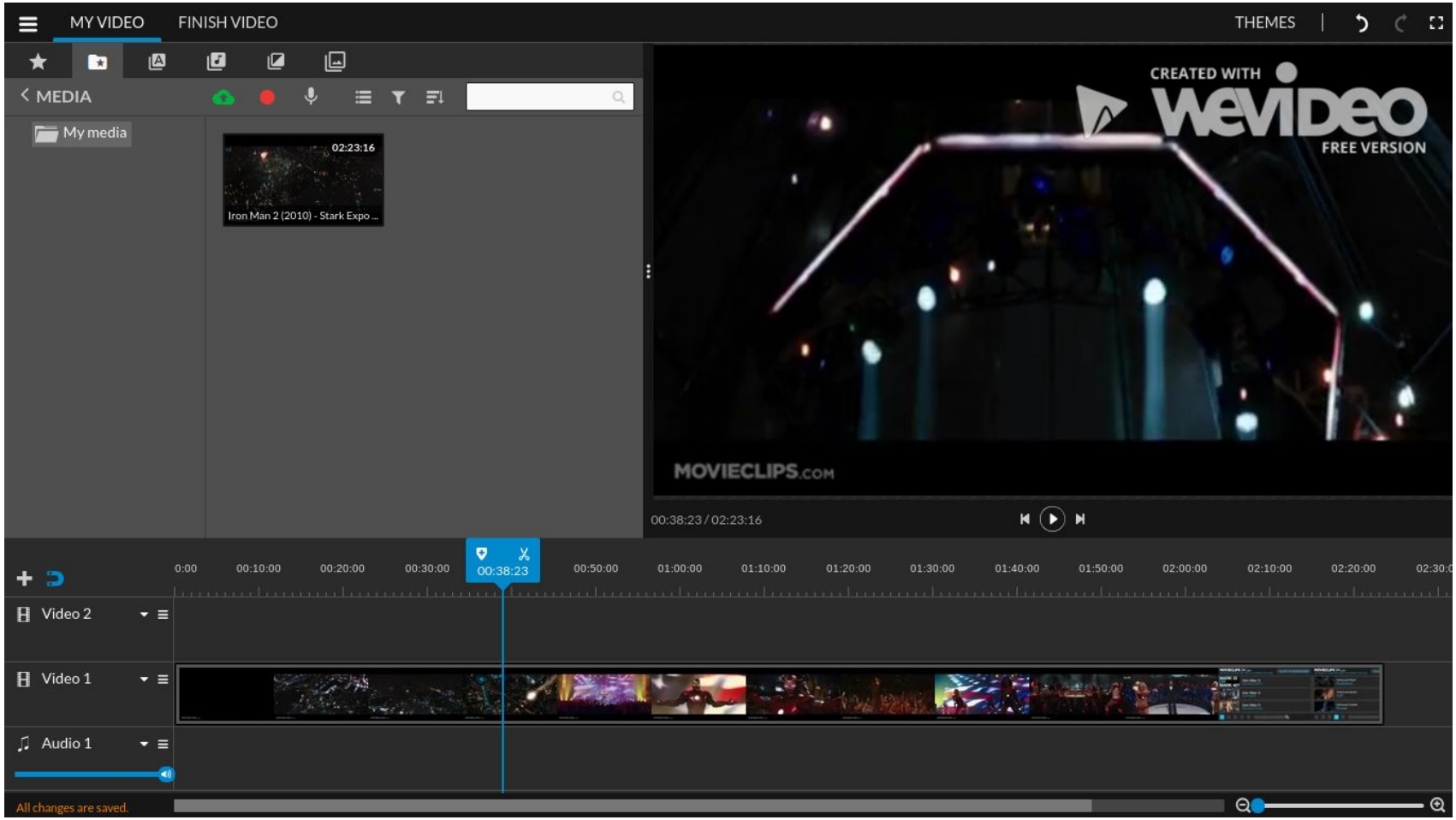


Analyzed Video:
Chrome App - WeVideo



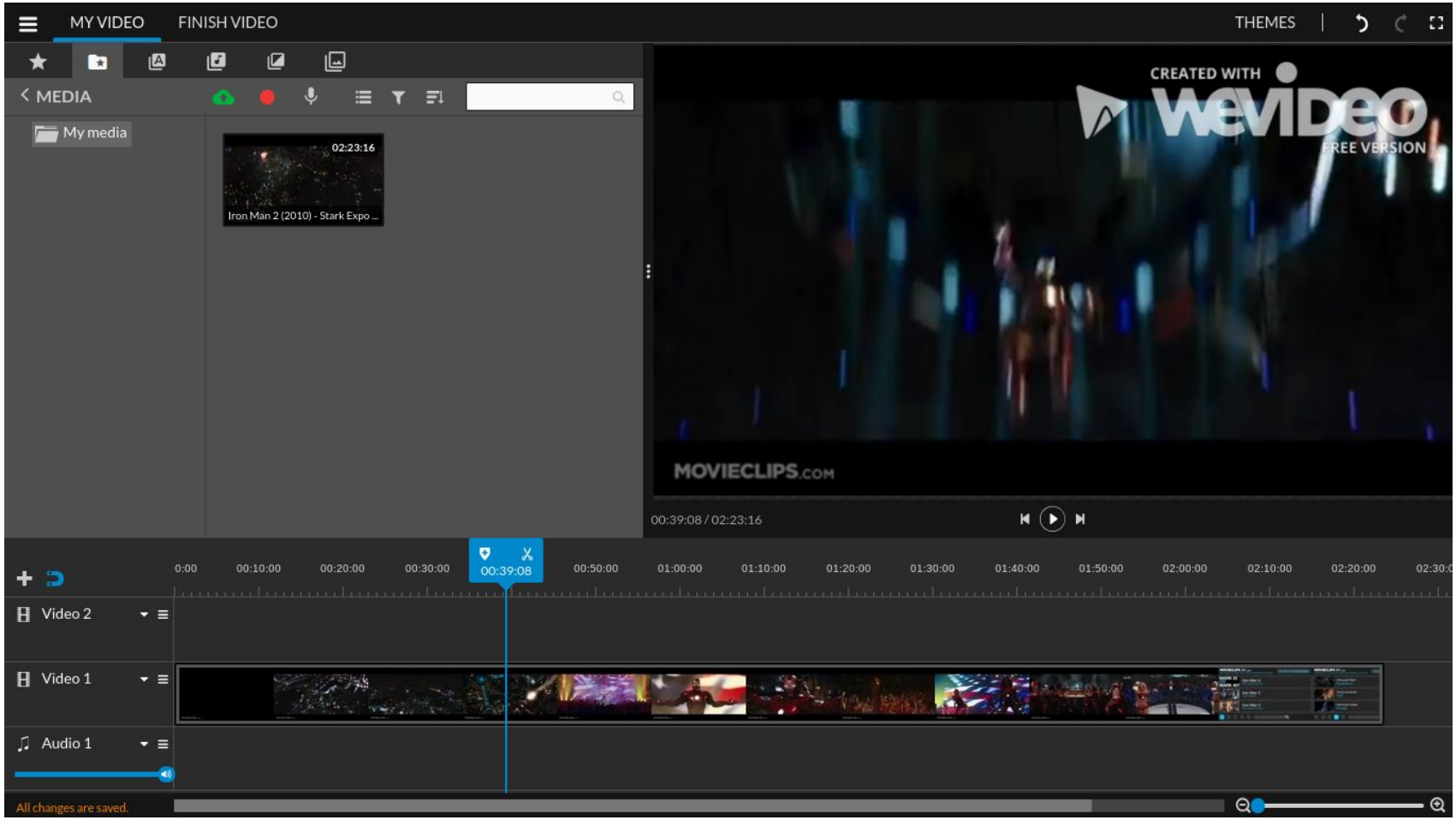
Video Analysis: 3. Data Collection

Video Analysis: Iron Man Landing



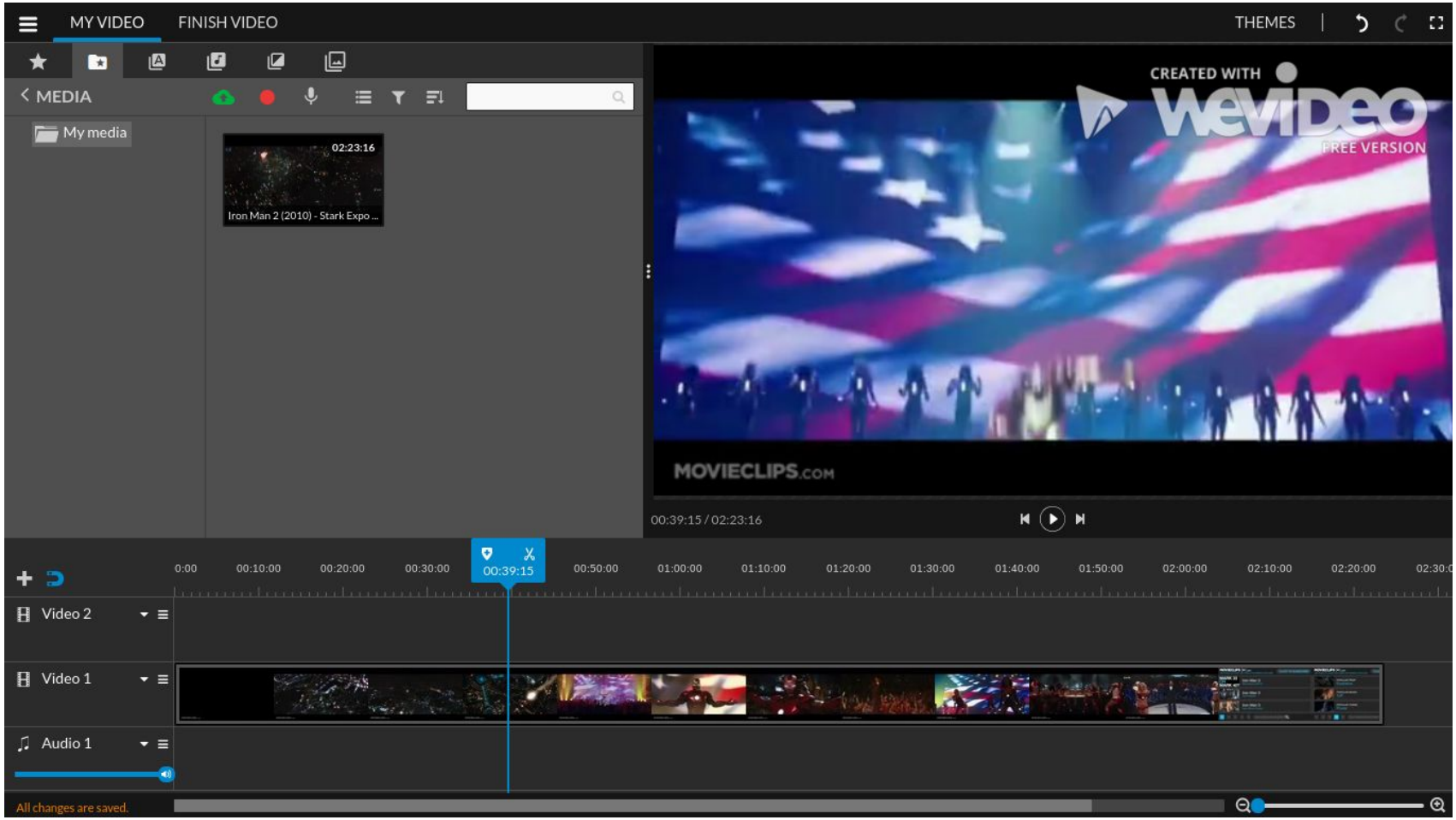
Video Analysis: 3. Data Collection

Video Analysis: Iron Man Landing



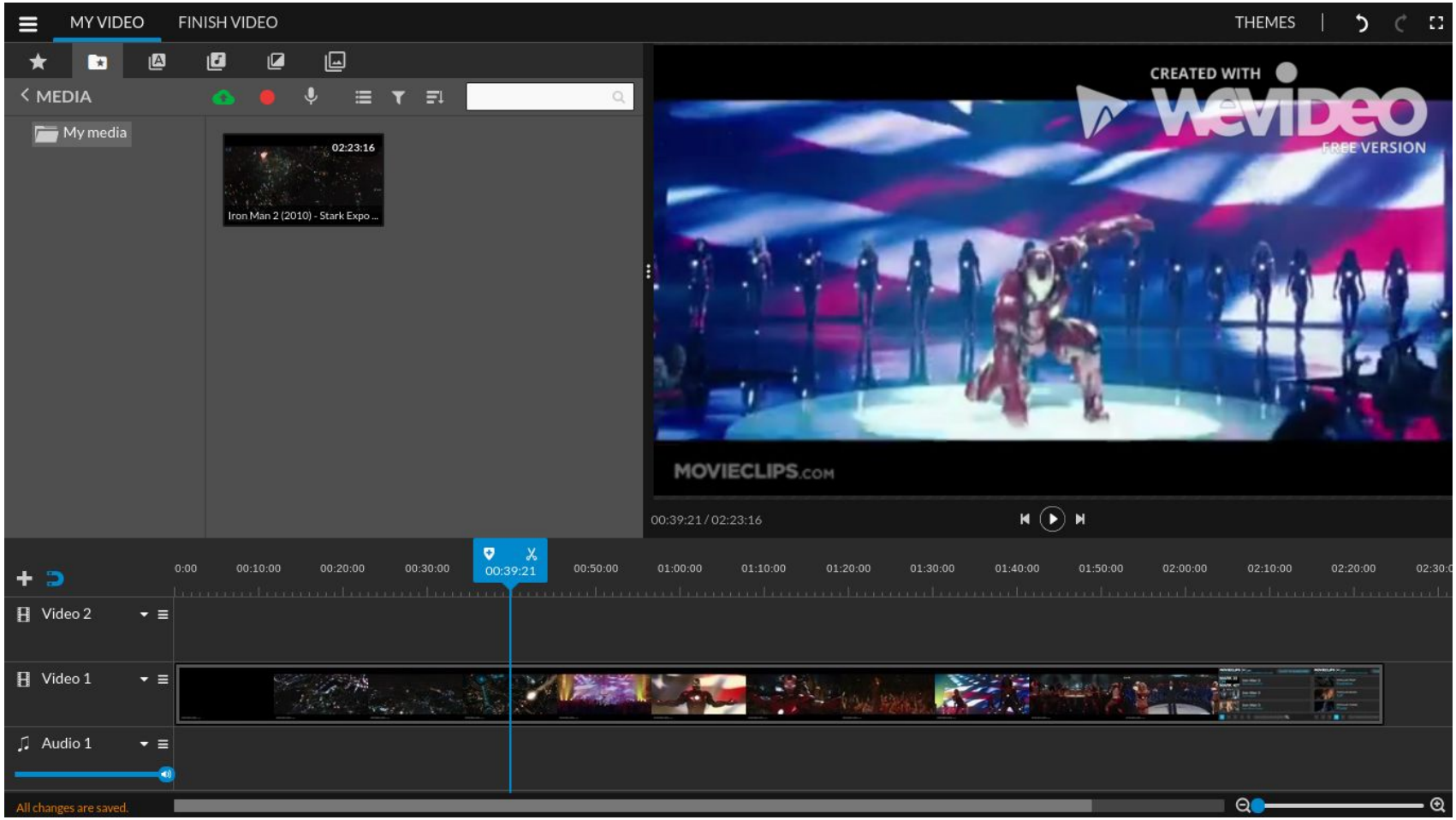
Video Analysis: 3. Data Collection

Video Analysis: Iron Man Landing



Video Analysis: 3. Data Collection

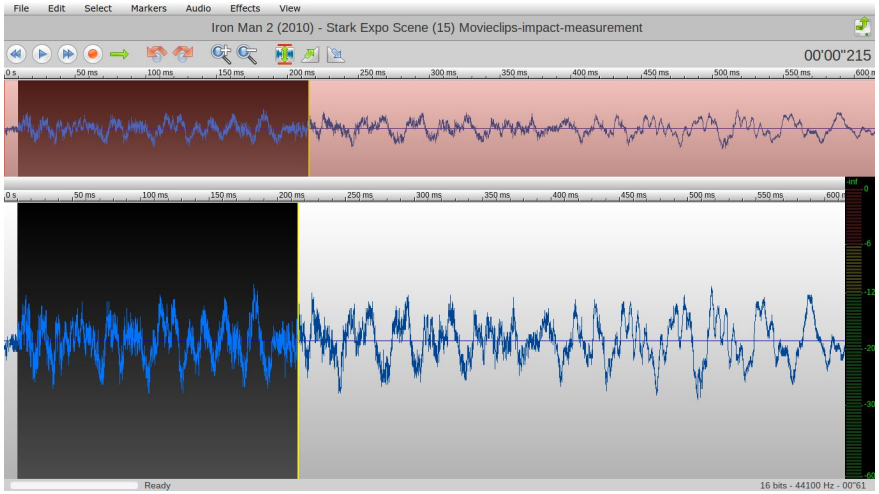
Video Analysis: Iron Man Landing



Video Analysis: 3. Data Collection

Video Analysis: Iron Man Landing

TwistedWave Online Audio Editor



From Video:

In building fall Duration (Min:Sec:60th):

0:38:23 to 0:39:13

60-23=37, 37+13=50,

50/60 = t_{fall} = **0.83 seconds**

Impact Sound Duration:

t_{impact} = 200 ms = **0.2 seconds**

Video Analysis: 3. Data Collection

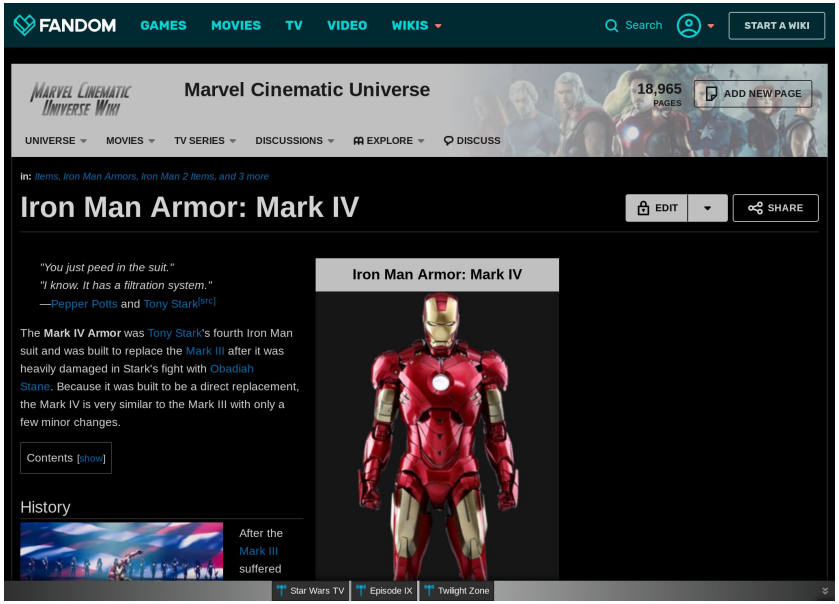
Video Analysis: Iron Man Landing

Weight = W_{Stark} = **225 lb_f**

Weight = $W_{In\ Armor}$ = **425 lb_f**

Marvel Cinematic Universe Wiki:

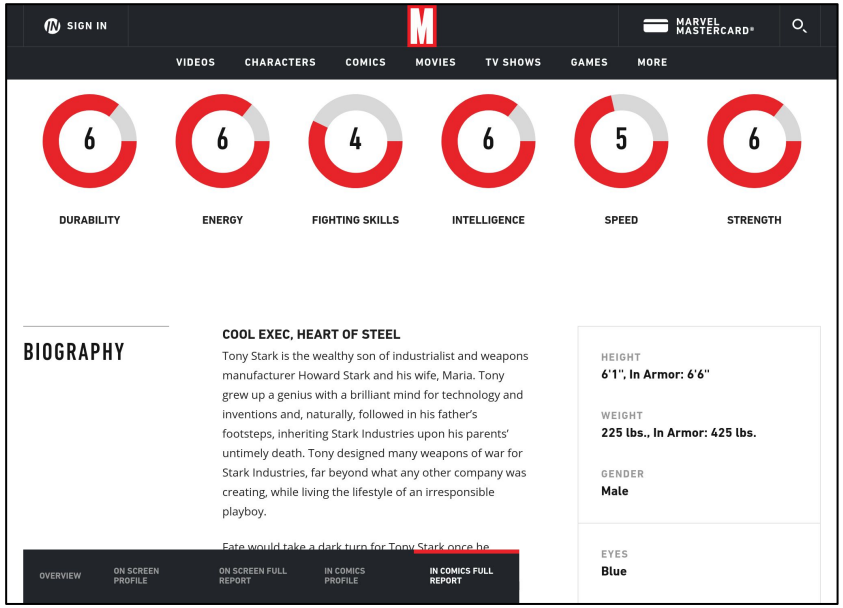
Iron Man Armor Mark IV



Marvel.com:

In Comics Full Report

Iron Man (Tony Stark)



Video Analysis: 3. Data Collection

Video Analysis: Iron Man Landing

Stadium Height Filming location

"The Expo is based around the remaining structures from the real **1964-65 New York World's Fair** in Flushing Meadow, Union Turnpike-44th Avenue."

[FILM-LOCATION]

Real Life Highest Stadium Height

Georgia Dome: **275 feet**

Superdome: 253 feet

Kingdome: 250 feet

Astrodome: 208 feet

Skydome: 142 feet

[HEIGHT-STADIUM]

Video Analysis: 3. Data Collection

Video Analysis: Iron Man Landing

Fastest Skydiving Terminal Velocity

- Highest speed **373.6 mph** by Henrik Raimer in 2016.

[TERMINAL]

Assumption: Neglect Air Resistance

- Special coating
- Material properties
- Terminal velocity

Video Analysis: 3. Data Collection

Video Analysis: Iron Man Landing

G Force (Number of G's)

- 1940 Air Force Physician John Stapp **46.2 G's**

1994 Journal Article Spine

- Sneeze **2.9 G's**
- Slap on back **4.1 G's**
- Plop into chair **10.1 G's**
- Jump from three feet up and land stiff-legged **100 G's**

Most People Pass Out

- **Head-to-toe 4 to 5 G's**
- Hearts can't pump enough pressure
- **Blood pools to our feet**
- Brain lacks oxygen
- **Too Much and Too Long**

Princess Diana:

Chest 70 G's tore pulmonary artery, Head 100 G's

[NOVA-PBS]

Video Analysis: 4. Math/Results

Video Analysis: Iron Man Landing

Givens:

$W_{Stark} = -275\ lb_f$

$\Rightarrow M_{Stark} = 275\ lb_m$

$g = 32.2\ ft/s^2$

$a = -g = -32.2\ ft/s^2$

$t_{fall} = 0.83\ s$

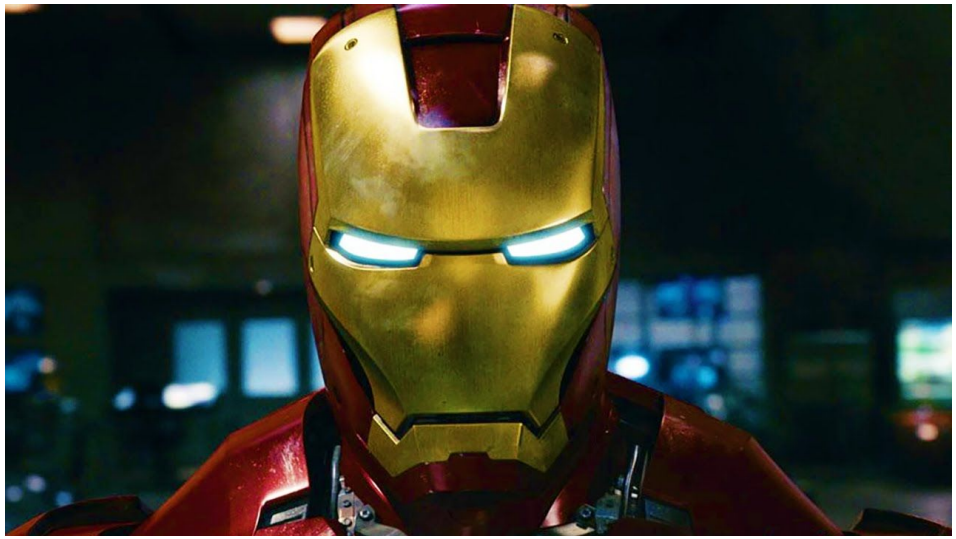
$t_{impact} = 0.2\ s$

$g_c = 32.2\ (lb_m\ ft)/(lb_f\ s^2)$

Height of fall

$\Delta y = y_f - y_i$

$= 0\ ft - 275\ ft = -275\ ft$



Video Analysis: 4. Math/Results

Video Analysis: Iron Man Landing

$$y = y_0 + v_0 t + (1/2)at^2$$

$$y_f = y_i + v_i(t_{fall}) - (1/2)g(t_{fall})^2$$

$$v_i = (y_f - y_i + (1/2)g(t_{fall})^2) / (t_{fall})$$

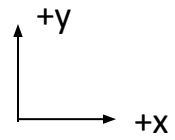
$$v_i = \frac{-275 \text{ ft} + (1/2)(32.2 \text{ ft/s2})(0.83 \text{ s})^2}{0.83 \text{ s}}$$

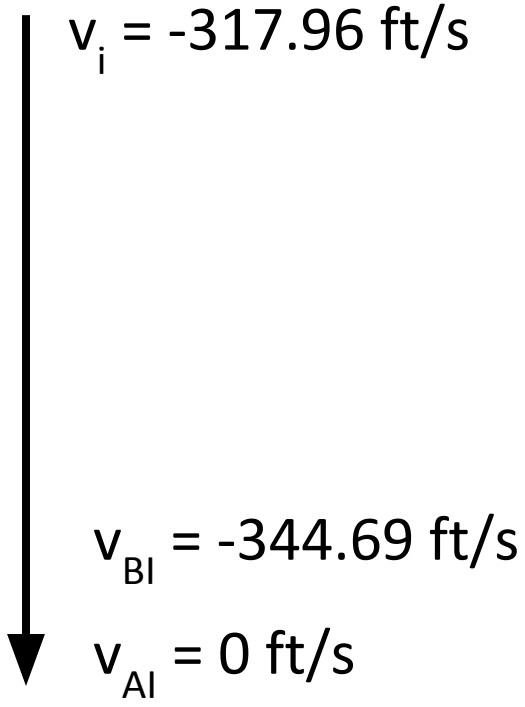
$$v_i = -317.96 \text{ ft/s} = -216.79 \text{ mph}$$

$$v = v_0 + at$$

$$v_{BI} = v_i - gt = (-317.96 \text{ ft/s}) - (32.2 \text{ ft/s}^2)(0.83 \text{ s})$$

$$v_{BI} = -344.69 \text{ ft/s} = -235.01 \text{ mph}$$





Video Analysis: 4. Math/Results

Video Analysis: Iron Man Landing

Impulse:

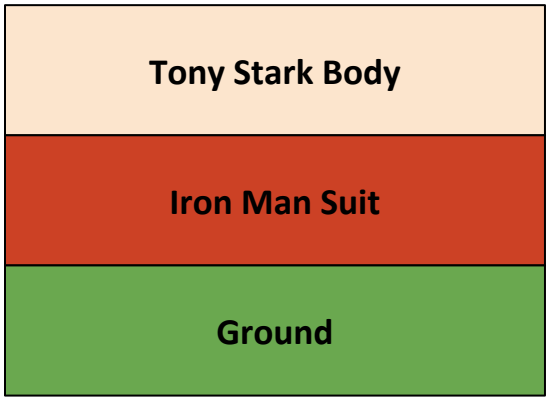
$$mv_1 + \sum F \Delta dt = mv_2$$

$$m_{Stark} v_i + (F_{Suit\ on\ Stark} - W_{Stark}) t_{Impact} = mv_{AI}$$

$$F_{Suit\ on\ Stark} = (-(m_{Stark} v_i)/(t_{Impact})) + W_{Stark}$$

$$F_{Suit\ on\ Stark} = (-(275\ lb_m \times -317.96\ ft/s) / (0.2\ s \times g_c)) + (275\ lb_f)$$

$$F_{Suit\ on\ Stark} = 13852.58\ lb_f$$



Video Analysis: 4. Math/Results

Video Analysis: Iron Man Landing

$F = ma$

$a = F/m$

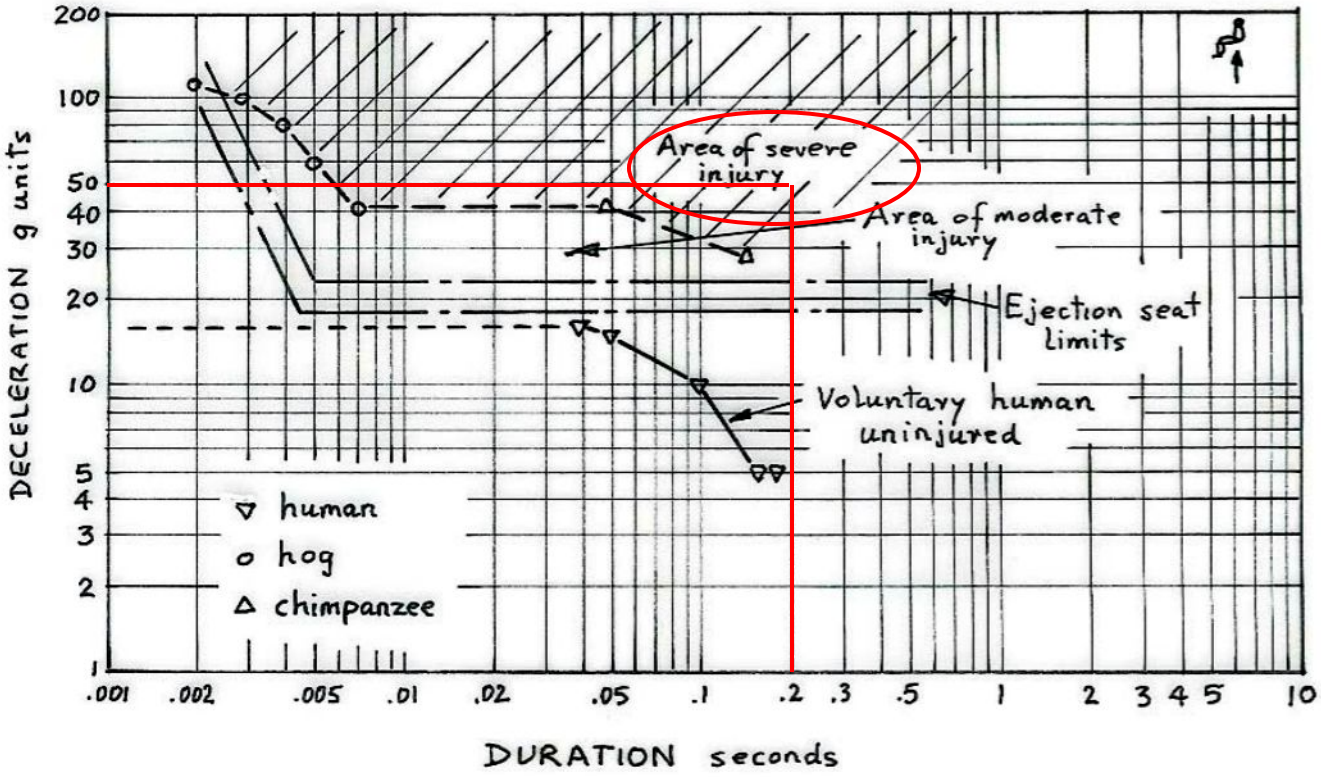
$a = 13852.58 / 275\ lb_m \times g_c$

$a = 1622.01\ ft / s^2$

$a/G's = (\ 1622.01\ ft / s^2\ ) / 32.2 =$ 50.37 G's of acceleration

Video Analysis: 5. What would really happen in real life?

Video Analysis: Iron Man Landing



Survivable abrupt positive G ($+G_z$) impact, from Eiband. [SURVIVE]

t_{impact} = 0.2 s G's = 50.37 G's

Video Analysis: 5. What would really happen in real life?

Video Analysis: Iron Man Landing

Weight: W_{Stark} = -275 lb_f

Time: t_{fall} = 0.83 s, t_{impact} = 0.2 s

Distance: Δy = -275 ft

Force: $F_{Suit\ on\ Stark}$ = 13852.58 lb_f

Acceleration: a = 1622.01 ft / s^2

G's = 50.37 G's

Plausible that Tony Stark could survive the fall, but would probably pass out, break some bones, spinal compression, and a concussion if not worse.

v_i = -317.96 ft/s

v_{BI} = -344.69 ft/s

v_{AI} = 0 ft/s

Movie ~~Magic~~ Physics not always realistic, but sometimes plausible.

Video Analysis: Works Cited

Video Analysis: Iron Man Landing

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