THE PIT AND THE PENDULUM
Using ELA Common Core standards
What ELA Standards Here?

1. (RL 1) Cite the **textual evidence** that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.

2. (RL4) Determine **the meaning of words and phrases as they are used in a text**, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.
3. (L4) Determine or clarify the meaning of unknown and multiple-meaning words or phrases a. Use context (e.g., the overall meaning of a sentence or paragraph; a word’s position or function in a sentence) clue to the meaning of a word or phrase.

4. (L5). Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
5. (SL 4). Present claims and findings (e.g., argument, narrative, response to literature presentations), emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
Key Demands

We need students to be able to...

- Read complex texts
- Read the text closely
- Interpret and analyze what they read using text-based evidence
- Use context clues to navigate new vocabulary
- Present findings to others in an articulate manner
Jigsaw Exercise

Work in a group of 4 – Count off from 1 to 4. Each group is assigned a page from the story.

Individual tasks (per your number in the group):

1. Summarize the plot.
2. Identify the theme, citing the text as evidence.
3. Identify emotions, explaining how these emotions are evident, and citing the text.
4. Identify a symbol, what it stands for, and how it is used in the text.

All identify new vocabulary.
Classroom Work: Poster project

The students in the group then place their findings on a poster.

The final step is that they present their poster (in numerical order according to assigned page number) to the class while the rest of the students take notes.
THE PIT AND THE PENDULUM

Math/Science Perspective
Science/Math View

- But how real is this escape?
- Could it have actually happened?
- What do we actually know about the situation?
  - What do we know about the pendulum?
  - What do we know about the time involved for the escape?
  - What do we know about the details of the escape?
The Big Question

How long does it take a 30 foot pendulum to complete 12 full swings (oscillations)?

If more than 1 minute – story might be true. If less than 1 minute then story is total nonsense!
Guiding Question

- What affects the time period of a pendulum?
  - Length?
  - Amplitude?
  - Weight of the bob?

- Your task:
  - Use the materials provided
  - Do some experiments to see if that variable affects the period of the pendulum
  - Be ready to share your findings
Development of the Math Unit

- Experimental error
- Normal distributions
  - Intuitively
  - Mathematically – by hand, then by calculator
- Standard pendulum – mean and standard deviation of period
- What affects the period?
- Curve fitting
- Experimental data to find equation for period
- Test the prediction
Thank You

- Thank you for attending this session

- Please feel free to contact me with further questions
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ELA Lesson to Use Before “Pit and the Pendulum” Unit

Standards Addressed:

Grade 9-10

Reading:
RL1: Cite the *textual evidence* that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.

RL 2: Determine *a theme or central idea* of a text and analyze in detail its development over the course of the text, including it emerges and is shaped and reinforced by specific details; provide an objective summary of the text.

RL 4: Determine *the meaning of words and phrases as they are used in the text*, including figurative and connotative meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g. how the language evokes a sense of time and place; how it sets a formal or informal tone).

Language:
L4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 9–10 reading and content, choosing flexibly from a range of strategies.
   a. Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word’s position or function in a sentence) as a clude to the meaning of a word or phrase.

L5: Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
   a. Interpret figures of speech (e.g., euphemism, oxymoron) in context and analyze their role in the text.
   b. Analyze nuances in the meaning of words with similar denotations

Speaking and Listening:
SL 4: Present information, findings, and supporting evidence clearly, conscisely, and logically (*using appropriate eye contact, adequate volume, and clear pronunciation*) such that listeners can following the line of reasoning and the organization development, substance and style are appropriate to purpose (e.g., argument, narrative, informative, response to literature presentations), audience, and task.
**Context of the Lesson:**
In the unit, which the English teacher did shortly before the math class was going to start with “The Pit and the Pendulum” unit, the students were looking at the writing of Edgar Alan Poe, and one of the pieces of Poe’s writing that they looked at was *The Pit and the Pendulum*. The lesson could be done independently as a lesson engaging students in the analysis of complex text.

**Introduction:**
The stage is set either reminding students of the context of the story (if they have been reading the story) or by teaching them a brief synopsis of the story. Students were each given a hard copy of the pages of the story used in the math unit. As a class, they read the excerpt from the math unit and briefly discussed the events described in the excerpt in the context of Poe’s complete story.

**Lesson (Day 1):**
Students were divided into groups of four, and each group was given one page from the excerpt used in the math unit. As a group they had to re-read their assigned page, and then divide the labor.

Each group member was responsible for one of the following tasks:
1) Summarize the plot  
2) Identify the theme, citing evidence from the text  
3) Identify emotions, explaining how these emotions are evident, citing evidence from the text  
4) Identify a symbol, what it stands for, and how it is used in the text.

All were responsible for identifying new vocabulary, and determining the meaning in the context of the story.

Group members then collaborated to prepare a poster to share their findings, including the new vocabulary and definitions. Emphasis was placed on the importance of citing textual evidence for the presentation.

**Lesson (Day 2):**
Group members had a few minutes to finish up their posters, and to prepare the presentation to the class. Groups then presented their work to the class, following the numeric order of the page numbers groups had been assigned. When listening to the presentations of other groups, students were required to take notes so that they could prepare a summary of findings as the final piece of the activity.
**Benefit to Students and Teachers:**
Students saw the inter-related nature of their work in school. The work they had done in their English class was then used in their math class, and the work in their math class had a very clear connection to physical science. For teachers there was an organic opportunity for cross-curricular collaboration.
You know that something determines the period of a pendulum, but it may not be clear exactly what that something is. Maybe there are several things.

In this activity, you will experiment to get an idea about what affects a pendulum’s period.

1. Your teacher will assign you a variable from the list made in class. Do some experiments to see if that variable affects the period of a pendulum.

2. Prepare a written report, describing what you did, what observations you made, and what questions you still have.
Looking upward, I surveyed the ceiling of my prison. It was some thirty or forty feet overhead, and constructed much as the side walls. In one of its panels a very singular figure riveted my whole attention. It was the painted figure of Time as he is commonly represented, save that in lieu of a scythe he held what at a casual glance I supposed to be the pictured image of a huge pendulum, such as we see on antique clocks. There was something, however, in the appearance of this machine which caused me to regard it more attentively. While I gazed directly upward at it (for its position was immediately over my own), I fancied that I saw it in motion. In an instant afterward the fancy was confirmed. Its sweep was brief, and of course slow. I watched it for some minutes, somewhat in fear but more in wonder. Wearied at length with observing its dull movement, I turned my eyes upon the other objects in the cell.

A slight noise attracted my notice, and looking to the floor, I saw several enormous rats traversing it. They had issued from the well which lay just within view to my right. Even then while I gazed, they came up in troops hurriedly, with ravenous eyes, allured by the scent of the meat. From this it required much effort and attention to scare them away.

It might have been half-an-hour, perhaps even an hour (for I could take but imperfect note of time) before I again cast my eyes upward. What I then saw confounded and amazed me. The sweep of the pendulum had increased in extent by nearly a yard. As a natural consequence, its velocity was also much greater. But what mainly disturbed me was the idea that it had perceptibly DESCENDED. I now observed, with what horror it is needless to say, that its nether extremity was formed of a crescent of glittering steel, about a foot in length from horn to horn; the horns upward, and the under edge evidently as keen as that of a razor. Like a razor also it seemed massy and heavy, tapering from the edge into a solid and broad structure above. It was appended to a weighty rod of brass, and the whole HISSED as it swung through the air.

I could no longer doubt the doom prepared for me by monkish ingenuity in torture. My cognisance of the pit had become known to the inquisitorial agents -- THE PIT, whose horrors had been destined for so bold a recusant as myself, THE PIT, typical of hell, and regarded by rumour as the Ultima Thule of all their punishments. The plunge into this pit I had avoided by the merest of accidents, and I knew that surprise or entrapment into torment formed an important portion of all the grotesquerie of these dungeon deaths. Having failed to fall, it was no part of the demon plan to hurl me into the abyss, and thus (there being no alternative) a different and a milder destruction awaited me. Milder! I half smiled in my agony as I thought of such application of such a term.

What boots it to tell of the long, long hours of horror more than mortal, during which I counted the rushing oscillations of the steel! Inch by inch -- line by line -- with a descent only appreciable at intervals that seemed ages -- down and still down it came! Days passed -- it might have been that many days passed -- ere it swept so closely over me as to fan me with its acrid breath. The odour of the sharp steel forced itself into my nostrils. I prayed -- I wearied heaven with my prayer for its more speedy descent. I grew frantically mad, and struggled to force myself upward against the sweep of the fearful scimitar. And then I fell suddenly calm and lay smiling at the glittering death as a child at some rare bauble.
The Pit and the Pendulum (Conclusion)

There was another interval of utter insensibility; it was brief, for upon again lapsing into life there had been no perceptible descent in the pendulum. But it might have been long -- for I knew there were demons who took note of my swoon, and who could have arrested the vibration at pleasure. Upon my recovery, too, I felt very -- oh! inexpressibly -- sick and weak, as if through long inanition. Even amid the agonies of that period the human nature craved food. With painful effort I outstretched my left arm as far as my bonds permitted, and took possession of the small remnant which had been spared me by the rats. As I put a portion of it within my lips there rushed to my mind a half-formed thought of joy -- of hope. Yet what business had I with hope? It was, as I say, a half-formed thought -- man has many such, which are never completed. I felt that it was of joy -- of hope; but I felt also that it had perished in its formation. In vain I struggled to perfect -- to regain it. Long suffering had nearly annihilated all my ordinary powers of mind. I was an imbecile -- an idiot.

The vibration of the pendulum was at right angles to my length. I saw that the crescent was designed to cross the region of the heart. It would fray the serge of my robe; it would return and repeat its operations -- again -- and again. Notwithstanding its terrifically wide sweep (some thirty feet or more) and the hissing vigour of its descent, sufficient to sunder these very walls of iron, still the fraying of my robe would be all that, for several minutes, it would accomplish; and at this thought I paused. I dared not go farther than this reflection. I dwelt upon it with a pertinacity of attention -- as if, in so dwelling, I could arrest HERE the descent of the steel. I forced myself to ponder upon the sound of the crescent as it should pass across the garment -- upon the peculiar thrilling sensation which the friction of cloth produces on the nerves. I pondered upon all this frivolity until my teeth were on edge. Down -- steadily down it crept. I took a frenzied pleasure in contrasting its downward with its lateral velocity. To the right -- to the left -- far and wide -- with the shriek of a damned spirit! to my heart with the stealthy pace of the tiger! I alternately laughed and howled, as the one or the other idea grew predominant.

Down -- certainly, relentlessly down! It vibrated within three inches of my bosom! I struggled violently -- furiously -- to free my left arm. This was free only from the elbow to the hand. I could reach the latter, from the platter beside me to my mouth with great effort, but no farther. Could I have broken the fastenings above the elbow, I would have seized and attempted to arrest the pendulum. I might as well have attempted to arrest an avalanche!

Down -- still unceasingly -- still inevitably down! I gasped and struggled at each vibration. I shrunk convulsively at its very sweep. My eyes followed its outward or upward whirls with the eagerness of the most unmeaning despair; they closed themselves spasmodically at the descent, although death would have been a relief, O, how unspeakable! Still I quivered in every nerve to think how slight a sinking of the machinery would precipitate that keen glistening axe upon my bosom. It was hope that prompted the nerve to quiver -- the frame to shrink. It was HOPE -- the hope that triumphs on the rack -- that whispers to the death-condemned even in the dungeons of the Inquisition.
The Pit and the Pendulum (Conclusion)

I saw that some ten or twelve vibrations would bring the steel in actual contact with my robe, and with this observation there suddenly came over my spirit all the keen, collected calmness of despair. For the first time during many hours, or perhaps days, I THOUGHT. It now occurred to me that the bandage or surcingle which enveloped me was UNIQUE. I was tied by no separate cord. The first stroke of the razor-like crescent athwart any portion of the band would so detach it that it might be unwound from my person by means of my left hand. But how fearful, in that case, the proximity of the steel! The result of the slightest struggle, how deadly! Was it likely, moreover, that the minions of the torturer had not foreseen and provided for this possibility! Was it probable that the bandage crossed my bosom in the track of the pendulum? Dreading to find my faint, and, as it seemed, my last hope frustrated, I so far elevated my head as to obtain a distinct view of my breast. The surcingle enveloped my limbs and body close in all directions save SAVE IN THE PATH OF THE DESTROYING CRESCENT.

Scarcely had I dropped my head back into its original position when there flashed upon my mind what I cannot better describe than as the unformed half of that idea of deliverance to which I have previously alluded, and of which a moiety only floated indeterminately through my brain when I raised food to my burning lips. The whole thought was now present -- feeble, scarcely sane, scarcely definite, but still entire. I proceeded at once, with the nervous energy of despair, to attempt its execution.

For many hours the immediate vicinity of the low framework upon which I lay had been literally swarming with rats. They were wild, bold, ravenous, their red eyes glaring upon me as if they waited but for motionlessness on my part to make me their prey. "To what food," I thought, "have they been accustomed in the well?"

They had devoured, in spite of all my efforts to prevent them, all but a small remnant of the contents of the dish. I had fallen into an habitual see-saw or wave of the hand about the platter; and at length the unconscious uniformity of the movement deprived it of effect. In their voracity the vermin frequently fastened their sharp fangs in my fingers. With the particles of the oily and spicy viand which now remained, I thoroughly rubbed the bandage wherever I could reach it; then, raising my hand from the floor, I lay breathlessly still.

At first the ravenous animals were startled and terrified at the change -- at the cessation of movement. They shrank alarmedly back; many sought the well. But this was only for a moment. I had not counted in vain upon their voracity. Observing that I remained without motion, one or two of the boldest leaped upon the frame-work and smelt at the surcingle. This seemed the signal for a general rush. Forth from the well they hurried in fresh troops. They clung to the wood, they overran it, and leaped in hundreds upon my person. The measured movement of the pendulum disturbed them not at all. Avoiding its strokes, they busied themselves with the anointed bandage. They pressed, they swarmed upon me in ever accumulating heaps. They writhed upon my throat; their cold lips sought my own; I was half stifled by their thronging pressure; disgust, for which the world has no name, swelled my bosom, and chilled with heavy clamminess my heart. Yet one minute and I felt that the struggle would be over. Plainly I perceived the loosening of the bandage. I knew that in more than one place it must be already severed. With a more than human resolution I lay STILL.
The Pit and the Pendulum (Conclusion)

Nor had I erred in my calculations, nor had I endured in vain. I at length felt that I was FREE. The surcingle hung in ribands from my body. But the stroke of the pendulum already pressed upon my bosom. It had divided the serge of the robe. It had cut through the linen beneath. Twice again it swung, and a sharp sense of pain shot through every nerve. But the moment of escape had arrived. At a wave of my hand my deliverers hurried tumultuously away. With a steady movement, cautious, sidelong, shrinking, and slow, I slid from the embrace of the bandage and beyond the reach of the scimitar. For the moment, at least I WAS FREE.

Free! and in the grasp of the Inquisition! I had scarcely stepped from my wooden bed of horror upon the stone floor of the prison, when the motion of the hellish machine ceased and I beheld it drawn up by some invisible force through the ceiling. This was a lesson which I took desperately to heart. My every motion was undoubtedly watched. Free! I had but escaped death in one form of agony to be delivered unto worse than death in some other. With that thought I rolled my eyes nervously around on the barriers of iron that hemmed me in. Something unusual -- some change which at first I could not appreciate distinctly -- it was obvious had taken place in the apartment. For many minutes of a dreamy and trembling abstraction I busied myself in vain, unconnected conjecture. During this period I became aware, for the first time, of the origin of the sulphurous light which illumined the cell. It proceeded from a fissure about half-an-inch in width extending entirely around the prison at the base of the walls which thus appeared, and were completely separated from the floor. I endeavoured, but of course in vain, to look through the aperture.

As I arose from the attempt, the mystery of the alteration in the chamber broke at once upon my understanding. I have observed that although the outlines of the figures upon the walls were sufficiently distinct, yet the colours seemed blurred and indefinite. These colours had now assumed, and were momentarily assuming, a startling and most intense brilliancy, that give to the spectral and fiendish portraits an aspect that might have thrilled even firmer nerves than my own. Demon eyes, of a wild and ghastly vivacity, glared upon me in a thousand directions where none had been visible before, and gleamed with the lurid lustre of a fire that I could not force my imagination to regard as unreal.

UNREAL! -- Even while I breathed there came to my nostrils the breath of the vapour of heated iron! A suffocating odour pervaded the prison! A deeper glow settled each moment in the eyes that glared at my agonies! A richer tint of crimson diffused itself over the pictured horrors of blood. I panted ' I gasped for breath! There could be no doubt of the design of my tormentors -- oh most unrelenting! oh, most demoniac of men! I shrank from the glowing metal to the centre of the cell. Amid the thought of the fiery destruction that impended, the idea of the coolness of the well came over my soul like balm. I rushed to its deadly brink. I threw my straining vision below. The glare from the enkindled roof illumined its inmost recesses. Yet, for a wild moment, did my spirit refuse to comprehend the meaning of what I saw. At length it forced -- it wrestled its way into my soul -- it burned itself in upon my shuddering reason. O for a voice to speak! -- oh, horror! -- oh, any horror but this! With a shriek I rushed from the margin and buried my face in my hands -- weeping bitterly.
The Pit and the Pendulum (Conclusion)

The heat rapidly increased, and once again I looked up, shuddering as if with a fit of the ague. There had been a second change in the cell -- and now the change was obviously in the FORM. As before, it was in vain that I at first endeavoured to appreciate or understand what was taking place. But not long was I left in doubt. The inquisitorial vengeance had been hurried by my two-fold escape, and there was to be no more dallying with the King of Terrors. The room had been square. I saw that two of its iron angles were now acute -- two consequently, obtuse. The fearful difference quickly increased with a low rumbling or moaning sound. In an instant the apartment had shifted its form into that of a lozenge. But the alteration stopped not here -- I neither hoped nor desired it to stop. I could have clasped the red walls to my bosom as a garment of eternal peace. "Death," I said "any death but that of the pit!" Fool! might I not have known that INTO THE PIT it was the object of the burning iron to urge me? Could I resist its glow? or if even that, could I withstand its pressure? And now, flatter and flatter grew the lozenge, with a rapidity that left me no time for contemplation. Its centre, and of course, its greatest width, came just over the yawning gulf. I shrank back -- but the closing walls pressed me resistlessly onward. At length for my seared and writhing body there was no longer an inch of foothold on the firm floor of the prison. I struggled no more, but the agony of my soul found vent in one loud, long, and final scream of despair. I felt that I tottered upon the brink -- I averted my eyes --

There was a discordant hum of human voices! There was a loud blast as of many trumpets! There was a harsh grating as of a thousand thunders! The fiery walls rushed back! An outstretched arm caught my own as I fell fainting into the abyss. It was that of General Lasalle. The French army had entered Toledo. The Inquisition was in the hands of its enemies.
The pendulum that is illustrated here will be called the *standard pendulum* for the rest of the unit.

Here are the specifications for this standard pendulum.

- Weight of bob: 1 washer
- Length of string: 2 feet
- Amplitude: 20°

As you investigate what determines a pendulum’s period, you will be looking at pendulums that differ in some respect from this one. You will compare their periods to the period of this one.

Find the period of this standard pendulum using the procedure agreed upon by your class, and record your result.

Repeat the experiment, again recording the period. Continue gathering more data as time allows.
Pendulum Variations

You have seen that you may get slightly different results each time you measure the period of the standard pendulum.

As noted in *Standard Deviation Basics*, you are making an assumption about these measurement variations.

**Normality Assumption**

If you make many measurements of the period of any given pendulum, the data will closely fit a normal distribution.

In *Standard Pendulum Data and Decisions*, you estimated both the mean and the standard deviation of this normal distribution.

In this activity, you will look at what happens to the period if the pendulum is changed in certain ways. You will then use the results from this activity to decide what factor or factors seem to determine the pendulum’s period.

In conducting your experiments, you should measure the period in exactly the same way as you did in *The Standard Pendulum*. For example, if in that activity you measured the time for 10 swings and then divided by 10 to get the period, you should do the same thing here.

Make each measurement twice, but treat each as a separate result. Do not average your two measurements.
In each experiment, your pendulum should be the same as the standard pendulum except for the characteristic being studied. Here again are the specifications of the standard pendulum.

- Weight of bob: 1 washer
- Length of string: 2 feet
- Amplitude: 20°

1. Changing the Weight

Measure the period of a pendulum that is the same as the standard pendulum except that it has a weight of 5 washers.

2. Changing the Length

Measure the period of a pendulum that is the same as the standard pendulum except that it is 4 feet long.

3. Changing the Amplitude

Measure the period of a pendulum that is the same as the standard pendulum except that it has an amplitude of 30°.
Based on earlier work, you have determined that the period of a pendulum seems to be a function of its length.

You will now gather some data about that function. Use the standard weight (1 washer) and standard amplitude (20°), but vary the length.

For each length that you examine, find the time for 12 periods, because the prisoner in Poe’s story thought there were about 12 swings remaining when he created his plan to escape.
The Thirty-Foot Prediction

Now that you have the data on the time required for 12 swings for pendulums of several different lengths, your task is to make a prediction for a 30-foot pendulum.

Look for a function $f$ that fits all of your data as well as possible. You probably won’t find a function that fits the data perfectly, but do the best you can.

Once you are satisfied with your choice of function, find $f(30)$. That is, find out what your function would predict as the time required for 12 swings of a 30-foot pendulum.

Now work with your classmates to build Poe’s pendulum and test your prediction.