



1. During this battle, one location was saved from capture by the actions of Gouverneur K. Warren and the cannons of Charles Edward Hazlett. One general in this battle disobeyed orders by placing his troops in the Peach Orchard, resulting in its decimation. Jeb Stuart's cavalry were unavailable for much of this battle, which was fought at locations including (*) Devil's Den and Little Round Top. This battle ended after a disastrous charge led by George Pickett. For 10 points, name this 1863 Civil War battle in which George Meade ended a Confederate invasion of the North in Pennsylvania.

ANSWER: Battle of Gettysburg

146-11-41-13102

2. An European convict song called “The Wanderer” describes crossing this body of water. A native species in this body of water is the oilfish “golomyanka” (go-lo-mye-ank-uh). The largest island in this body of water is named Olkhon. It is drained by the Angara River and saw its water level increase after the impounding of the (*) Irkutsk (UR-kootsk) Dam. For 10 points, name this body of water once crossed by the Trans-Siberian Railway, the world’s deepest and most voluminous freshwater lake.

ANSWER: Lake Baikal

052-11-41-13103

3. In addition to creating the Furies, the blood from the castration of Uranus created the Meliae, which represented these objects. The sisters of Phaethon transformed into them after their death. For their hospitality to Zeus and Hermes, the old couple Baucis and Philemon were transformed into these upon their death. Another figure who was transformed into one of these was the daughter of Pentheus, who was chased by Apollo; that figure was (*) Daphne. For 10 points, name these objects which were represented by Dryads.

ANSWER: Trees [accept more specific answers]

048-11-41-13104

4. One of this man's plays mentions the central family's third son Eugene, who died when his older brother gave him measles. That play by this author contains the flirtatious maid Cathleen and Doc Hardy. This author also described Don Parritt, Larry Slade, and Hickey, patrons of Harry (*) Hope's bar, and he created the morphine-addicted Mary, matriarch of the Tyrone family. For 10 points, identify this American dramatist who wrote *The Iceman Cometh* and *Long Day's Journey into Night*.

ANSWER: Eugene Gladstone O'Neill

020-11-41-13105

5. This artist depicted an elderly figure emerging from behind a curtain as a golden cherub flies above the title character in his painting *Danae*. A father bestows a necklace upon his red-clad daughter in this man's painting *The Jewish Bride*. A glowing golden girl and a dog barking at a drummer appear in a crowd with (*) Willem van Ruytenburch and Frans Banning Cocq in a painting by this man displayed in the Rijksmuseum. For 10 points, name this Dutch artist of *The Night Watch*.

ANSWER: Rembrandt Harmenszoon van Rijn [accept Rembrandt van Rijn]

124-11-41-13106

6. After this event, American Indian groups protested that one figure was code named “Geronimo.” A famous Pete Souza photograph showed the planners of this event and is unofficially titled *The Situation Room*. Barack Obama said “we don’t need to spike the football” when declining to publicly release photos of this event’s aftermath. Officially named Operation Neptune Spear, this action took place at a compound near (*) Abbottabad, with the Pakistani government only informed after it was finished. For 10 points, identify this May 2011 action which saw Navy SEALs terminate the head of al-Qaeda.

ANSWER: Death of Osama bin Laden [or equivalents for “death”; or Operation Neptune Spear until mentioned]

052-11-41-13107

7. This group was responsible for the movement of the relics of St. Cuthbert and possibly the Book of Kells due to their attacks on Lindisfarne and Iona. This group was twice paid off to stop their siege of Paris by Charles the Fat when they were led by Rollo. Fighters in this group's armies included (*) housecarls and fighters who would work themselves into a frenzy and fight without armor known as berserkers. For 10 points, name this group that used longships to raid along the European coast from the ninth to eleventh century, and which was composed of Scandinavian warriors.

ANSWER: vikings [or Norsemen; or Northmen]

023-11-41-13108

8. This quantity equals the natural logarithm of the number of possible states multiplied by the Boltzmann constant. Heat content divided by temperature equals a change in this quantity as defined by Rudolph Clausius. Dividing the quantity of enthalpy minus Gibbs free energy by temperature results in this measurement that increases over (*) time according to the second law of thermodynamics. For 10 points, name this quantity that measures a system’s randomness.

ANSWER: entropy

130-11-41-13109

9. These characters realize that they cannot remember what happened prior to the current day in one work, which opens with one of them declaring that the laws of probability are void as a flipped coin has come up tails several dozen times in a row. In a different play, they are ironically killed by pirates after a subterfuge involving a substituted letter to the (*) King of England requesting their murders. For 10 points, name these Danish courtiers who, according to an ambassador's proclamation in *Hamlet* and the title of a Tom Stoppard play, "are dead."

ANSWER: Rosencrantz and Guildenstern

019-11-41-13110

10. After a phenol-chloroform extraction, this substance is used to precipitate the extracted DNA. A beta-mercapto form of this compound is a powerful reducing agent used in protein gel electrophoresis. Zymase and invertase are used by baker’s (*) yeast to produce it from sugars, and over-consumption of this substance leads to cirrhosis of the liver. For 10 points, name this substance which is formed in fermentation, an alcohol with formula CH₃CH₂OH.

ANSWER: ethanol or ethyl alcohol [prompt on alcohol]

048-11-41-13111

11. In Sumerian myth, this object was represented by the consort of Ningal, named Sin. Another deity of this object was the mother of Pandia and had fifty children with a figure who lived on Mount Latmus. In Aztec myth it is created when Huitzilopochli decapitates his sister. At Ragnarok, Hati eats this object. The Greek goddess of this object put (*) Endymion into an endless sleep. For 10 points, name this object, which in Greek myth is associated with Selene and in Roman myth with Luna.

ANSWER: Moon

048-11-41-13112

12. Minnie Vautrin's diaries are an important account of this event, which was filmed by the missionary John Magee. A German businessman named John Rabe established a Safety Zone during this event, which supposedly started as a 100-man killing contest. The editing of this event out of history textbooks is an ongoing controversy in the nations involved. During this event tens of thousands of women were raped and hundreds of thousands of (*) Chinese civilians were killed. For 10 points, name this 1937 massacre conducted by the Japanese Army in a namesake eastern Chinese city.

ANSWER: Rape of Nanking [or Nanking Massacre; or Rape of Nanjing; or Nanjing Massacre]

048-11-41-13113

13. The incorporation of a heavy version of this element was used to show that DNA replication is semi-conservative in the Meselson-Stahl experiment. This element is bound to oxygen in a powerful gaseous blood vessel dilator. The diatomic form of this element has a very strong (*) triple bond, which is why legumes contain Rhizobia (rie-ZOH-bee-ah) in their roots to transform it into ammonia. That process is known as this element's "fixation". For 10 points, name this element, with atomic number 7 and symbol N.

ANSWER: nitrogen

048-11-41-13114

14. One character in this work tells of a dream in which a snake eats eight young birds, but turns to stone after eating their mother; shortly thereafter, that character thwacks the wicked Thersites with his scepter. The "Catalog of Ships" makes up much of Book Two of this twenty-four book work. At its beginning, the priest Chryses demands the return of his (*) daughter from Agamemnon, who proceeds to take Briseis as compensation from Achilles. For 10 points, name this epic about the Trojan War written by Homer.

ANSWER: *The Iliad*

080-11-41-13115

15. The PCE index is used to measure the "core" version of this process in the United States. Measures of it can incorrectly overestimate it due to the Base Effect, and it is measured using a consumer price index. The (*) cost-push type of it can result in a wage spiral, and the demand-pull type is caused by increased spending. The Weimar Republic experienced a "Hyper-" version of it due to overprinting. For 10 points, name this economic phenomenon, which is a general rise in prices over time.

ANSWER: inflation

048-11-41-13116

16. This poem's third stanza declares "little town, thy streets for evermore will silent be" and asks "Who are these coming to the sacrifice?" Earlier, the speaker notes that "heard melodies are sweet, but those unheard are sweeter" and addresses the subject as "foster-child of silence and slow time." The addressee is described as "a friend to man, to whom thou say'st, (*) 'Beauty is truth, truth beauty,'" and this poem begins with the line, "Thou still unravished bride of quietness." For 10 points, name this ode by John Keats about a piece of pottery.

ANSWER: "Ode on a Grecian Urn"

014-11-41-13117

17. **This composer's *Piano Concerto No. 20* is one of only two he composed in a minor key. Another of this composer's works was completed after his death by Franz Süssmayr. His solo piano works include a sonata with a "Rondo Alla Turca" third movement. His divertimenti include *A Musical Joke*, while his serenades include (*) *Eine Kleine Nachtmusik*. For 10 points, name this Austrian composer of an unfinished *Requiem* and forty-one symphonies, including the "Jupiter."**

ANSWER: Johann Chrysostom Wolfgang Amadeus Mozart

014-11-41-13118

18. **The Jacobi elliptic functions are used to solve this system, which traces out an ellipse in phase space. The height displacement of one of these is used in ballistics to measure bullet speed. Gravity and tension are the only two forces that work on these systems to restore them to (*) equilibrium where they have no potential energy. These simple harmonic oscillators are composed of a bob attached to a pivot. For 10 points, name these systems found in certain types of old clocks.**

ANSWER: pendulums

124-11-41-13119

19. **The number of people who died during this event was depicted in an 1869 flow chart by Charles Joseph Minard. Prince Bagration died during it. The Kazan Cathedral is intended as a memorial to one country's victory during it. The bloodiest moment in this event occurred at Borodino, where General Kutuzov ultimately retreated. More than 300,000 troops were killed in the disastrous (*) retreat after this event, which involved crossing the Berezina River in winter. For 10 points, identify this event of 1812 that saw a French emperor's forces destroyed shortly after taking Moscow.**

ANSWER: Napoleon's invasion of Russia [accept synonyms for "invasion"; or Patriotic War of 1812; or France's invasion of Russia before France is read; prompt on Battle of Borodino before it is read]

052-11-41-13120

20. **Techniques in this art form include the Maxi Ford, the Cincinnati, and the flap-ball-change. This dance technique features in the musical *Bring in da Noise, Bring in da Funk*, which was choreographed by Savion Glover. Other pioneers in this form include Gregory Hines and(*) "Bojangles" Robinson. The title piece of *Singin' in the Rain* features Gene Kelly performing this type of dance. For 10 points, identify this dance form based on its namesake percussive shoes.**

ANSWER: tap dancing

020-11-41-13121

21. **This element, when attached to four methyl groups, is the calibration standard for NMR; that compound is TMS. The Czochralski process is used to form crystals of this element, and it is chlorinated in the Seimens process. Like carbon, this element forms four single bonds. This element is the second most abundant one in the earth's (*) crust, and is the second lightest metalloid. For 10 points, name this element commonly used in transistors and computer chips, with atomic number 14 and symbol Si.**

ANSWER: silicon

048-11-41-13122

22. **This man fought for the Brazilian separatist state Rio Grande do Sul during the War of Tatters. He joined the Colorados and led a faction of the navy against Juan Manuel de Rosas in the Uruguayan Civil War. After he led the Hunters of the Alps to victory at Bezzeca, the terms of the Treaty of Villafranca strained his relationship with Count Cavour. He also conquered (*) Naples and Sicily during the Expedition of a Thousand with his Redshirts. For 10 points, name this soldier who helped Victor Emmanuel II become the first king of a unified Italy.**

ANSWER: Giuseppe Garibaldi

079-11-41-13123

23. **Two characters in this novel are woken up by Geever, who scrapes off the gum under their bed. The protagonist of this novel sets up his shy friend with a stutter with a Portland prostitute named Candy. The majority of this novel's characters are divided into Chronics and Acutes, who are told to be violent to one another during group meetings. It ends with (*) Chief Bromden suffocating Randall McMurphy, who is lobotomized by Nurse Ratched. For 10 points, identify this novel set in an asylum, written by Ken Kesey.**

ANSWER: *One Flew Over the Cuckoo's Nest*

020-11-41-13124



1. The title character of this play has a son with Helen of Troy in Part II. For 10 points each:

[10] Name this play in which Mephistopheles makes a bet with God over the soul of the title character, who abandons the pregnant Gretchen.

ANSWER: ***Faust***

[10] This German author of *Faust* was a member of the *Sturm und Drang* movement.

ANSWER: Johann Wolfgang von **Goethe** (GUR-tuh)

[10] In this novel by Goethe, which takes the form of letters from the title character to his friend Wilhelm, the title character kills himself due to his love for Lotte.

ANSWER: *The Sorrows of Young Werther*

105-11-41-13201

2. Early systems of this type were inaccurate because they used very large wavelengths. For 10 points each:

[10] Name this system that uses radio waves and their reflections to identify objects.

ANSWER: **RADAR** or **radio detecting and ranging**

[10] Radar exploits this effect, which explains why sirens get louder as they get closer to the observer and quieter as they go farther away.

ANSWER: **Doppler** effect

[10] This other sensor technology uses reflected laser pulses to image things like clouds. It's also used to measure the distance to the moon.

ANSWER: **LIDAR** [or **light detecting and ranging** or **LADAR** or **laser detecting and ranging**]

137-11-41-13202

3. This leader gave BBC radio broadcast to inspire revolution in his home country while serving as the leader of the Free French Forces. For 10 points each:

[10] Name this first president of France's Fifth Republic who granted independence to Algeria.

ANSWER: Charles-Andre-Joseph-Marie **de Gaulle**

[10] De Gaulle was taken prisoner in this 1916 World War I battle, in which the Germans, led by Falkenhayn, attacked the French under Robert Nivelle at a fortification on the Meuse River.

ANSWER: Battle of **Verdun**

[10] This other French commander at Verdun led Vichy France with his Prime Minister Pierre Laval during World War II.

ANSWER: Henri Philippe Benoni Omer Joseph **Pétain**

124-11-41-13203

4. Onstage, this character often carries a picnic basket, a suitcase full of sand, and a coat as props. For 10 points each:

[10] Name this character who delivers a stream-of-consciousness monologue when his hat is placed on his head and he is told by the other characters to "think."

ANSWER: **Lucky**

[10] Lucky and his master Pozzo, along with Vladimir and Estragon, are characters in this absurdist play.

ANSWER: ***Waiting for Godot*** [or ***En attendant Godot***]

[10] *Waiting for Godot* was written by this Irish author of *Endgame* who wrote in both French and English.

ANSWER: Samuel Barclay **Beckett**

020-11-41-13204

5. This fleet was ultimately commanded by the Duke of Medina-Sidonia, and, despite being heavily outgunned, its leaders hoped to overcome that limitation through boarding and sheer numbers. For 10 points each:

[10] Name this fleet of over one hundred ships that completely failed in its attempt to invade England.

ANSWER: Spanish **Armada** [or Invincible **Armada**; or **Armada** Espanola; or **Armada** Invencible]

[10] The Armada was sent by this Spanish king, who also built the Escorial palace.

ANSWER: **Philip II** [or **Felipe II**; prompt on **Philip**; prompt on **Felipe**]

[10] The launch of the Armada was delayed several times, including once by Francis Drake's raid on this port, an action he called "sing[e] the King of Spain's beard."

ANSWER: **Cadiz**

003-11-41-13205

6. Its section "Of Human Bondage" discusses how humans view perfection in terms of preconceived types, and it stated that reality was perfection and our limited view made it look imperfect. For 10 points each:

[10] Name this work presented in a geometrical order and advocated a form of pantheism by equating an "absolutely infinite being" with God.

ANSWER: **Ethics**

[10] The Ethics was written by this Dutch philosopher, who also wrote On the Improvement of the Understanding and the Theologico-Political Treatise.

ANSWER: Baruch de **Spinoza**

[10] Spinoza was a notable critic of this religion, whose members, he argued, were in fact not the chosen people. Notable proponents of this religion include Akiva, Hillel, and Shimon Bar Yohai.

ANSWER: **Judaism**

048-11-41-13206

7. One operetta with this male character in the title features "Beautiful Insect With Golden Wings," a duet in which Jupiter's part consists of the buzzing of a fly. For 10 points each:

[10] Name this frequent operatic subject, who, in that 1858 operetta, is "in the underworld" to rescue his wife Eurydice (yur-ID-ih-see).

ANSWER: **Orpheus** [or **Orfee**]

[10] *Orpheus in the Underworld* was composed by this Prussian-born French musician, who also created *Tales of Hoffman* and *La Perichole* (PER-ee-shol).

ANSWER: Jacques **Offenbach**

[10] Later in *Orpheus in the Underworld*, the "Grand Galop Infernal" plays while the characters perform this iconic high-kicking dance of late nineteenth century Paris.

ANSWER: the **can-can**

019-11-41-13207

8. Upside-down houses and a church can be seen in the upper right of this painting. For 10 points each:

[10] Name this painting which also shows a woman milking a cow in the upper left, and shows the profile views of a sheep and a green man.

ANSWER: **I and the Village**

[10] *I and the Village* is a work by this Belorussian artist, who also depicted some soldiers and a burning house in his *White Crucifixion*.

ANSWER: Marc **Chagall** [or Moïshe **Shagal**]

[10] The Eiffel Tower can be seen through a window in the background of this Chagall self-portrait, in which the artist is depicted gesturing at a painting of a cow.

ANSWER: *Self Portrait with **Seven Fingers***

141-11-41-13208

9. Ayatollah Khomeini issued a fatwa calling for this man's death after an unflattering depiction of Muhammad in this man's book *The Satanic Verses*. For 10 points each:

[10] Name this author who won the Booker Prize for a novel narrated by Saleem Sinai, who is born at the moment of the partition of India.

ANSWER: Salman **Rushdie**

[10] Name that novel, whose title group consists of others born at the same time as Saleem, who is rivaled by Shiva.

ANSWER: ***Midnight's Children***

[10] This enlarged body part is Saleem's most prominent feature. Saleem first recognizes his telepathy after he hits it falling in a closet.

ANSWER: **nose**

121-11-41-13209

10. This work concluded that emotional distress arises from cultural, not biological, reasons. For 10 points each:

[10] Name this anthropological work that focuses on adolescent girls from the title island group.

ANSWER: ***Coming of Age in Samoa***

[10] This anthropologist conducted the field research that led to her publication of *Coming of Age in Samoa*.

ANSWER: Margaret **Mead**

[10] Boas also served as an adviser to this other female anthropologist whose works include *Patterns of Culture* and *The Chrysanthemum and the Sword*.

ANSWER: Ruth **Benedict** [accept Ruth **Fulton**]

124-11-41-13210

11. The narrator of this work mocks the story of Heloise and Abelard and considers a Turkish bath “fairly ordinary.” For 10 points each:

[10] Name this travelogue in which the American narrator visits Marseilles, Constantinople, and Jerusalem while traveling on the *Quaker City*.

ANSWER: *The **Innocents Abroad***

[10] *The Innocents Abroad* was written by this American author of *Pudd'nhead Wilson*, better known for two novels about Huck Finn and Tom Sawyer.

ANSWER: Mark **Twain** [or Samuel Langhorne **Clemens**]

[10] Huck Finn travels down the Mississippi River with this escaped slave, who, unknowingly, is actually free for most of the novel.

ANSWER: **Jim**

080-11-41-13211

12. A dinner in the first section of this novel culminates with *boeuf en daube*, (BOOF on DOAB) which the hostess considers “a perfect triumph.” For 10 points each:

[10] Name this novel about the Ramsays and their guests at the family's summer home.

ANSWER: ***To the Lighthouse***

[10] *To the Lighthouse* was written by this woman, who also wrote the essay *A Room of One's Own* and the novel *Mrs. Dalloway*.

ANSWER: Virginia **Woolf**

[10] In *To the Lighthouse*, Lily Briscoe is disturbed when Charles Tansley tells her that women can't write or do this. Lily nevertheless engages in this activity, finishing at the novel's conclusion.

ANSWER: **painting** [or obvious equivalents]

121-11-41-13212

13. One scene in this work sees a bird and a duck argue while the title character's pet cat attempts to catch them. For 10 points each:

[10] Name this 1936 composition for narrator and orchestra which was written for children. Its title boy is represented by the strings; the title creature, by the French horn.

ANSWER: **Peter and the Wolf** [or **Petya i volk**]

[10] *Peter and the Wolf* was written by this Russian composer, whose other works include the *Lieutenant Kije Suite* and the *Scythian Suite*.

ANSWER: Sergei Sergeevich **Prokofiev**

[10] Truffaldino and Smeraldina are characters from Prokofiev's most famous opera, which sees the son of the King of Clubs become cursed by Fata Morgana to fall in love with these objects.

ANSWER: three **oranges** [or *The Love for Three **Oranges***; or trois **oranges**; or *L'amour des Trois **Oranges***]

048-11-41-13213

14. This President was responsible for sending out the Great White Fleet, and, after leaving office, this man went on a safari. For 10 points each:

[10] Name this President who came to power following the assassination of William McKinley.

ANSWER: **Theodore Roosevelt** [or **Teddy Roosevelt**; prompt on **Roosevelt**]

[10] Roosevelt's domestic policy was centered on this series of programs and legislations that included trust busting and consumer protection acts like the Pure Food and Drug Act.

ANSWER: **Square Deal**

[10] Among the legislation of the Square Deal were the Elkins and Hepburn Act, both aimed at regulating this industry previously targeted by the Interstate Commerce Act of 1887 and the case *Wabash v. Illinois*.

ANSWER: **railroad** industry

064-11-41-13214

15. Answer the following about the geography of an African nation, for 10 points each.

[10] Pretoria, Bloemfontein and Capetown are the three capitals of what nation whose largest city is Johannesburg?

ANSWER: **South Africa**

[10] The longest river in South Africa is what colorful body of water that starts in the Drakensburg Mountains and empties from the Alexander Bay into the Atlantic Ocean?

ANSWER: **Orange** River

[10] The Orange River actually starts along the border between South Africa and what nation that only shares a border with South Africa because it is located entirely within it?

ANSWER: **Lesotho**

147-11-41-13215

16. This book features Jacob marrying Rachel but also being tricked into marrying her sister Leah. For 10 points each:

[10] Name this Biblical book which sees Jacob and his family eventually ending up in Egypt, where Jacob's beloved son has achieved a high rank after being sold into slavery by his brothers.

ANSWER: Book of **Genesis**

[10] This is the name of Jacob's beloved son, who is resented by his brothers because he is given a "coat of many colors" and has dreams about his brothers bowing down before him.

ANSWER: **Joseph**

[10] This youngest of Jacob's sons was the second and last son of Rachel. Joseph tests his brothers by planting a silver cup in this young man's bag and seeing how the brothers react when he threatens to enslave this sibling.

ANSWER: **Benjamin**

052-11-41-13216

17. It is the idea behind fractals, and the Ackermann function does not have the primitive version of this property. For 10 points each:

[10] Name this phenomenon of a function or algorithm being defined in terms of itself.

ANSWER: **recursion** [accept word forms]

[10] A classic function that is defined recursively is this one, which is symbolized by an exclamation point. It is the product of all positive integers less than or equal to the input.

ANSWER: **factorial**

[10] The Euclidean algorithm, which can be implemented recursively or iteratively, is a method for finding this value with respect to two numbers, by dividing one by the other and repeating the process with each new remainder until a remainder of 0 is reached.

ANSWER: **greatest common divisor**

142-11-41-13217

18. Daniel Ortega currently leads this country, but he had previously lost an election to the National Opposition Union-backed Violeta Barrios de Chamorro. For 10 points each:

[10] Name this country, whose Contra militia was secretly funded by the Reagan administration in the Iran-Contra scandal.

ANSWER: Republic of **Nicaragua** [or Republica de **Nicaragua**]

[10] The Contras opposed this group, which was founded by Carlos Fonseca. Jaime Wheelock was the head of its Marxist faction.

ANSWER: **Sandinistas** [or **Sandanista** National Liberation Front; or Frente **Sandanista** de Liberacion Nacional; or **FSLN**]

[10] The Sandinistas overthrew a dynasty of leaders with this surname. The first figure to hold this name was assassinated by Rigoberto Lopez Perez and installed puppet presidents like Leonardo Arguello.

ANSWER: **Somoza**

048-11-41-13218

19. These organelles are referred as rough or smooth. For 10 points each:

[10] Identify this cell organelle consisting of a network of tubules and vesicles which transport proteins.

ANSWER: **endoplasmic reticulum** [or **ER**]

[10] This specialized form of the ER is present in muscle cells, where it releases calcium when its ryanodine (rie-YAN-oh-deen) receptors are activated.

ANSWER: **sarcoplasmic reticulum** [or **SR**]

[10] The endoplasmic reticulum is contained within this fluid that makes up much of the cell.

ANSWER: **cytosol** [prompt on **intracellular fluid**]

020-11-41-13219

20. It equals the amount of heat necessary to raise the temperature of one kilogram of a substance by one degree Celsius. For 10 points each:

[10] Name this thermodynamic quantity. A molar version of a similar quantity equals this quantity times the molar mass.

ANSWER: **specific heat** capacity [do not accept "heat capacity"]

[10] This law states that at high temperatures, the molar heat capacity of all metals equals roughly twenty-five joules per mole-Kelvin.

ANSWER: Law of **Dulong** and **Petit** [or **Dulong-Petit** Rule]

[10] By the Third Law of Thermodynamics, and in accordance with the Einstein and Debye models, the specific heat of any substance approaches this value as temperature approaches absolute zero.

ANSWER: **zero**

003-11-41-13220

21. For 10 points each, answer these questions about the Hertzsprung-Russell diagram used in astronomy.

[10] The diagram measures a star's temperature versus this property which quantifies brightness and comes in apparent and absolute forms.

ANSWER: **luminosity**

[10] At the lower left of the diagram are these objects, supported by electron degeneracy pressure, formed by stars that are too light to become a neutron star.

ANSWER: **white dwarf**

[10] A white dwarf often explodes as a supernova if it exceeds this mass limit, equal to about 1.4 solar masses.

ANSWER: **Chandrasekhar** (chan-DREH-suh-kar) limit

064-11-41-13221