

### Tossups

1. In a feast painting by this artist, Pickle Herring and Hans Wurst cozy up to a suspiciously thick-necked “lady” sitting in front of phallic bagpipes. This artist of *Merrymakers at Shrovetide* depicted a somber-looking boy, with a drooping red feather in his cap, holding up a skull. An owl perches on the shoulder of a grinning woman lifting a beer mug in another of his paintings. This artist became famous as a painter of group portraits, such as the *Banquet of the Officers of the St. George Militia Company*. This painter from Haarlem created *Malle Babbe* and a portrait of a man with an upturned mustache and a goatee staring directly at the viewer with a smirk on his face. For 10 points, name this Dutch painter of *The Laughing Cavalier*.

ANSWER: Frans Hals

2. This property is exploited immediately prior to the edge-contraction phase of Karger's min-cut algorithm. Every problem in NP has a proof that is checkable by an algorithm with this property, according to the PCP theorem. By the Martin-Löf definition, a sequence has this property if no constructive martingale succeeds on it, or if all its prefixes are Kolmogorov-incompressible. A runtime of “big-O of  $n \log n$ ” is achievable even for worst-case inputs when quicksort is modified to run with this property. Depending on whether or not they always produce a correct result, algorithms with this property are classified as Las Vegas or Monte Carlo. For 10 points, identify this property desirable in cryptographic applications, which is informally equivalent to unpredictability.

ANSWER: randomness [or word forms; or randomized algorithms]

3. One character in this poem tells a story of an orphan girl falsely accused and executed for the theft of a pearl necklace, which is then found in a magpie nest built into the scales of balance of a statue of Justice. One part of this poem describes how “the deep-voiced neighboring ocean speaks” and receives an answer “in accents disconsolate.” The two main characters of this poem are the children of the farmer Benedict and the blacksmith Basil, respectively, and are from the town of Grand-Pré. The protagonist of this poem works as a Sister of Mercy in Philadelphia, where she is reunited with her lover, Gabriel Lajeunesse. For 10 points, name this poem beginning “This is the forest primeval,” a Henry Wadsworth Longfellow poem about an Acadian woman.

ANSWER: Evangeline, *A Tale of Acadie*

4. The second ruler of this name killed his predecessor Kamba and allegedly sold a giant gold nugget for a bad price before dying of sleeping sickness. The first ruler of this name has been credited with establishing the sanankuya, or “joking relationship,” before drowning in the Sankarani River. That ruler with this name was supposedly helped by the marriage of his sister Nana Triban, who discovered the totem of an enemy ruler was a white cockspur. This name was held by a ruler who was assisted by his griot Balla Fasseke in defeating the Sosso king Sumanguru at the Battle of Kirina, which led that ruler to establish a capital at Niani as the first mansa in the Keita dynasty. For 10 points, identify this name of the founder of the Mali Empire.

ANSWER: Sundiata Keita [or Mari Djata]

5. The Rachford-Rice equation is used with this equation to do flash calculations. An application of this law to Beckmann's thermometer allowed him to calculate molecular weights. Though it can be modified by Margules functions, in its general form, this equation gives the K-value as the ratio of two pressures. The straight line on a P-x-y diagram is a consequence of this law. The modified form of it multiplies one side by the activity coefficient and the other side by a fugacity coefficient. This law is used to calculate dew points and bubble points. It only applies at high concentrations, or for compounds like pentane and hexane, which form ideal solutions. For 10 points, name this law which sets a gas' partial pressure equal to its mole fraction in the liquid phase times the vapor pressure.

ANSWER: Raoult's Law

6. One of a set of three piano pieces by this composer includes instructions for lighting and extinguishing a lantern; the other two pieces in that set are titled “On a vessel” and “On a helmet.” A piece by this composer, whose manuscript does not indicate instrumentation or tempo marking aside from the phrase “Very slow,” includes instructions for playing the theme 840 times in a row. He parodied Muzio Clementi in his *Sonatine bureaucratique*, and composed *Vexations*. This composer of “furniture music” is best known for a set of three piano pieces, the first

of which is marked “Lent et douloureux,” which evoke ancient Greek dances. For 10 points, name this French composer of the *Gymnopédies*.

ANSWER: Erik Alfred Leslie Satie

7. During this time period, people recite a poem whose name means "And we will recount the power," the Unetanneh Tokef. On this time period's final day, married men sometimes wear a white robe called a *kittel*. During this time span, one might hear commands such as "Sh'varim teruah" and "tekiah," and many services contain the Avinu Malkeinu prayer. Some people during this time period scatter bread crumbs in a river. It includes the Fast of Gedaliah. People seek *teshuvah* during this time period, which uses a prayer book called the *Mahzor*. The Book of Life is open in this part of the month of Tishrei. It ends on a day on which leather shoes are banned. For 10 points, name this time period in which the shofar is used, ending on a fast day devoted to atonement ten days after the Jewish new year.

ANSWER: the High Holy Days [or the Ten Days of Awe; or the Ten Days of Repentance; or the Ten Days of Penitence; or Yamim Nora'im; accept any answer indicating the time between Rosh Hashanah and Yom Kippur, though the time period is inclusive of both of those holidays; accept "Rosh Hashanah and Yom Kippur" even though many of these clues also apply to the time between them; prompt on "Tishrei," "Rosh Hashanah," "Yom Kippur," or "Jewish New Year"]

8. Unusually, this phenomenon occurs with complementizers in West Flemish and other Dutch dialects. According to the standard approach to this phenomenon, it involves a probe with an unvalued feature searching its c-command domain for a goal with a corresponding valued feature. Like case licensing, it can take place in a specifier-head configuration. In Bantu languages, it involves noun class prefixes attached to verbs and other sentential elements. In French, it occurs between nouns and the determiners and adjectives which modify them. This phenomenon, which is also known as concord, occurs between the subject and the verb in English. For 10 points, name this phenomenon in which two or more linguistic elements match in person, gender, or some other feature.

ANSWER: agreement [accept concord before mentioned]

9. Walter Map claimed that this group would “raze villages and churches” when establishing itself in a new location; early members of this group favored building on sites “of horror and vast solitude” in line with the description in Deuteronomy 32:10. Stephen Harding was a founding member of this group, for which he wrote the “Charter of Charity.” Armand-Jean le Bouthillier de Rance started a branch of this group that follows a “strict observance.” This religious order was founded after Robert of Molesme started an abbey at Cîteaux. A member of this order who was responsible for its explosive growth was convinced by Eugene III to preach the Second Crusade. For 10 points, name this order of White Monks that includes the Trappists and was once led by Bernard of Clairvaux.

ANSWER: Cistercian Order

10. This character is given a wardrobe based on the work of cartoonist Charles Burns and is contrasted with the ungrateful Princess Pirlipat in a Mark Morris staging. Baryshnikov had her throw a candleholder in a climactic scene. In the popular Balanchine staging, she sits off to the side and watches the Trepak danced by Russian dancers and the “Tea Dance” performed by Chinese dancers. Her impish brother Fritz breaks a toy given to her by her godfather, the magician Drosselmeyer. That object becomes life-size and helps an army of gingerbread soldiers defeat the Mouse King and his army. She goes to the Land of Sweets and witnesses the Dance of the Snowflakes and Dance of the Sugar Plum Fairy. For 10 points, name this girl from Tchaikovsky’s ballet *The Nutcracker*.

ANSWER: Clara [or Marie]

11. Pili in *Mycobacterium tuberculosis* use the enzyme that synthesizes this compound to bind to laminin. The export of this compound by SLAC1 in guard cells at high levels of carbon dioxide is required for stomatal closure. Glyoxylate condenses with acetyl Co-A to form this compound. This compound is not an amino acid, but it is transported from mesophyll cells to bundle sheath cells in C4 plants, since it can be formed by carboxylating, then reducing, PEP. It is antiported against alpha-ketoglutarate to shuttle electrons from glycolysis into the mitochondrion, a role it shares with aspartate. The addition of water to fumarate gives this compound. Its oxidation yields oxaloacetate in the final step of the citric acid cycle. For 10 points, name this dicarboxylic acid that makes fruits like apples taste sour.

ANSWER: malate [or malic acid]

12. Erwin Komenda created the distinctive design of one of these objects, which was produced by a company saved by Ivan Hirst. Norbert Konrad and Heinz Meixner used the same one of these objects to perform the same feat only three months apart, and Horst Breistoffer modified another one called an Isetta to do the same action at Checkpoint Charlie. One of these objects was made out of Duroplast and was generally more expensive to buy used than new. Birgit Kinder's "Test the Best" graffiti shows one of these objects crashing through the Berlin Wall; that type of this object was said to have its value doubled by filling it with gas. For 10 points, name these objects that in Germany included Sachsenring's notorious Trabant and the Beetle produced by Volkswagen.

ANSWER: cars [or automobiles; or autos; accept Volkswagen Beetle until "Isetta"]

13. In a novel with this noun in its title, Charles Meunier performs a blood transfusion to revive Bertha's maid and Bertha is accused of plotting to poison Latimer, who believes he can see the future. In another novel with this noun in its title, Charles Townsend has an affair with Kitty, whose husband Walter Fane orders her to accompany him to a cholera outbreak in China. Those novels are by George Eliot and Somerset Maugham, respectively. In a story named for one of these objects, Elizabeth breaks off her engagement with the title character, Reverend Hooper, who refuses to take off one of these objects. For 10 points, name this object worn by a minister in a short story by Nathaniel Hawthorne.

ANSWER: veil

14. One thinker from this country compared the ideal to a "flower" whose roots are in "material existence" after stating that "facts come before ideas." That man from this country coined the term "invisible dictatorship." Another thinker from here attacked Thomas Henry Huxley by identifying a "factor of evolution" called *Mutual Aid*, and wrote *The Conquest of Bread* before living as an exiled prince in England. *God and the State* was written in this country, where a later radical called imperialism "the highest stage of capitalism" and attacked Eduard Bernstein's evolutionary socialist views by advocating for a "vanguard" in *What Is To Be Done?* For 10 points, name this home country of anarchist Mikhail Bakunin, prince Peter Kropotkin, and Communist Vladimir Lenin.

ANSWER: Russia

15. This character's love interests include Lydia, who rejects him due to a two-month age difference. One character worries that this character will bring shame upon his family because he "pats birds on the head" to cheer himself up. He gives a wedding present of eggshells to Miss Othmar. He dreads growing old and having to wear "bifocal teeth," and he sometimes becomes distressingly "aware of his tongue." He responds to one girl's unrequited love for him by shouting, "I'm not your sweet babboo!" This character celebrates Halloween by waiting for a certain figure to rise up out of the most sincere patch. For 10 points, name this believer in the Great Pumpkin and second-baseman on Charlie Brown's team, who is the brother of Lucy and Rerun and carries a security blanket.

ANSWER: Linus van Pelt [prompt on van Pelt]

16. This city was where furniture magnate Amos Rhodes built his mansion Le Reve. In 1946, the deadliest hotel fire in American history occurred in this city when 119 people died in the "absolutely fireproof" Winecoff Hotel. Willis Venable ran a soda fountain in this city's Jacobs' Pharmacy. A speech given in this city used an analogy of a ship on the Amazon River being repeatedly told to "cast down your bucket where you are." Asa Candler was a mayor of this city, where the Cotton States and International Exposition of 1895 led to a compromise named for it after a speech by Booker T. Washington. For 10 points, name this city where John Pemberton developed the secret formula for making Coca-Cola in Georgia.

ANSWER: Atlanta

17. The speaker of one poem by this author remarks that "life to me had less of that fell look it wore" after the sky, the north wind, sickness, and death sequentially talk to him. The speaker of another of his poems shot someone "because he was my foe." Another poem by this poet of "The Subalterns" and "The Man He Killed" ends with images of Stourton Tower, Camelot, and "starlit Stonehenge." The speaker of another of this man's poems wishes for "some vengeful god" to blame for his unhappiness. This poet of "Channel Firing" and "Hap" wrote "consummation comes, and jars two hemispheres" in a poem about the sinking of the Titanic. One of his speakers hears a joyful birdsong against a dreary landscape as he "leant upon a coppice gate." For 10 points, name this author of "The Convergence of the Twain" and "The Darkling Thrush."

ANSWER: Thomas Hardy

18. In electrodynamics, the partial derivative of this quantity with respect to the four-potential gives the negative of the current density. For a central force, this object's lack of explicit dependence on the azimuthal angle gives rise to Kepler's laws. In order to derive one result about this quantity's time integral, one considers variations of a path with fixed endpoints, and finds a path for which that integral is extremized. Under that result, the partial derivatives of this functional yield the equations of motion, via a set of equations named for Euler and this quantity's French namesake. For 10 points, identify this dynamical quantity which is equal to kinetic energy minus potential energy, and whose integral with respect to time is the action.

ANSWER: Lagrangian [or Lagrangian density]

19. In a street celebration honoring this deity, people make human pyramids to reach a pot called the *matki* and break it. This deity told a pregnant mother about how to make the Chakravyuha military formation, though the unborn baby Abhimanyu only heard some of it and died at age sixteen screwing it up. This deity saved a village from a storm sent by Indra by raising the Govardhan hill over the village. This brother of Balarama defeated Kamsa, his evil uncle. His ranging with cowherd girls called *gopis* and his sucking of the demoness Putana's breastmilk are celebrated during Holi. During the Kurukshetra war, he declared "Now I am become death, destroyer of worlds" while revealing his full splendor. For 10 points, name this avatar of Vishnu who served as Arjuna's charioteer in the *Bhagavad-Gita*.

ANSWER: Krishna [or Krsna]

20. One character in this play is fined for using indecent language in court when he says "A fart has no nose" while verbally sparring with the judge. In this play, a dying villager suddenly regains his health when he discovers that the civil war is over and he can no longer be drafted. The protagonist of this play disguises herself in order to escape through the mountains, after which she marries Yussup, even though she is already engaged to Simon. The main plot of this play is a parable told by the Singer during a land dispute between two Soviet communes. In this play, based on a Yuan dynasty play, Grusha rescues the child Michael and cannot bear to hurt him by pulling him out of the title figure drawn on the ground. For 10 points, name this play by Bertolt Brecht.

ANSWER: *The Caucasian Chalk Circle* [or *Der Kaukasische Kreidekreis*]

TB1. The rate of this process is increased at Chi sequences. A protein named for this process cooperates with LexA to initiate the SOS response. The RuvABC family of proteins participates in this process. Mutations in BRCA1, which interacts with Rad51 protein during this process, lead to high rates of breast cancer. Cre proteins recognize loxP sites and initiate this process to occur. If the replication fork collapses, then this process involves strand invasion, branch migration, and then the resolution of the tetrahedral Holliday junction, all designed to repair the DNA. Targeted genes undergo this process during gene knockout. This process occurs at a chiasma during prophase I of meiosis. For 10 points, name this mechanism by which DNA strands exchange nucleotides, such as during crossover.

ANSWER: homologous recombination [or chromosomal crossover before it is read; or crossing over before crossover is read; prompt on DNA repair]

TB2. Jean-Bernard Bossu and Peter Martyr both inaccurately described this game as being similar to a game they were more familiar with. Jean de Brebeuf reported that this game was used for sick people. This game served as a distraction that led to the capture of the British-controlled Fort Michilimackinac. Handsome Lake asked that this game be played while he was on his deathbed, and it was unsuccessfully used to settle ownership of a beaver pond between the Creek and Choctaw. This game, known as the "little brother of war," had its rules and field size set by George Beers. Early versions of this game could have thousands of players on fields miles long with a filled-deerskin or wooden ball. For 10 points, name this stick game often used as training for war by Native American tribes.

ANSWER: lacrosse

### Bonuses:

1. These proteins form octamers with tails that can be methylated or acetylated to regulate DNA transcription. For 10 points each:

[10] Name these proteins around which DNA is wrapped to form chromatin.

ANSWER: histones

[10] Histones are rich in basic residues, especially these *two* amino acids which are positively charged at neutral pH. One of them has a guanidinium side chain, and the other has a free amino group which can easily be acetylated.

ANSWER: lysine and arginine [or K and R; or Lys and Arg; or opposite order; must have both for points]

[10] Methylation also occurs directly on nucleotides; for example, at these sites, where a namesake pyrimidine is methylated at the 5 carbon when it lies next to a namesake purine. They are especially common in promoters.

ANSWER: CpG islands [or CpG sites; or CG sites; or CGI; or cytosine and guanine instead of C and G]

2. This author wrote about Mathieu trying to get money for Marcelle's abortion in the novel *The Age of Reason*. For 10 points each:

[10] Name this author who shacked up with Simone de Beauvoir and detailed Antoine Roquentin's existential distress in *Nausea*.

ANSWER: Jean-Paul Sartre

[10] Sartre's short story "The Wall" takes place during this war. The novel *The Shadow of the Wind* is set in the aftermath of this war, in which George Orwell served.

ANSWER: Spanish Civil War

[10] Sartre wrote a preface to a major anthology of the Négritude movement published by Senghor. That preface is named after this Greek mythological figure.

ANSWER: Orpheus [or Black Orpheus]

3. This piece was rejected by the Vienna Music Society for its controversial use of a "nonexistent" inverted ninth chord. For 10 points each:

[10] Name this piece that, though originally a string sextet, is more commonly performed in its arrangement for string orchestra. It is named after a Richard Dehmel poem about a man and a woman walking through a dark forest.

ANSWER: Transfigured Night [or Verklärte Nacht]

[10] This one-act monodrama for a solo soprano depicts the interior monologue of a woman looking for her lover in a forest. The score has no organized repetition and has no formal structural organization, mimicking the stream-of-consciousness state it represents.

ANSWER: Erwartung [or Expectation]

[10] *Transfigured Night* and *Erwartung* were both composed by this Austrian composer who invented the twelve-tone system.

ANSWER: Arnold Schoenberg

4. This author's "Wonderland Quartet" is named after a novel about the life of Jesse Vogel. For 10 points each:

[10] Name this extremely prolific author, whose "Gothic Saga" includes the magical realist novel *Bellefleur*. She wrote about a family from Mt. Ephraim, New York in *We Were the Mulvaney*s.

ANSWER: Joyce Carol Oates

[10] The black man Jinx Fairchild kills a white man to protect Iris Courtney in Oates' *Because It Is Bitter, and Because It Is My Heart*, which gets its title from a poem by this author of *The Red Badge of Courage*.

ANSWER: Stephen Crane

[10] The third novel in the Wonderland Quartet is this one, about the struggle of the Wendall family in Detroit. Its main characters are Loretta and her children Maureen and Jules.

ANSWER: them

5. Proper names for this being include Julunggul and Yurlunggur. For 10 points each:

[10] Name this supreme being which came from beneath the ground and shaped the landscape by moving about during the Dreamtime. It now presides over, or perhaps inhabits, the world's water holes.

ANSWER: the Rainbow Serpent [if someone tries to be a jerk and give one of the hundreds of more specific names, anti-prompt them, I guess]

[10] The Rainbow Serpent is revered in this country by hundreds of different aboriginal groups.

ANSWER: Australia

[10] After the Dreamtime, one of these objects was turned into the first woman when the light goddess Yhi shone light on it. The Welsh beauty Blodeuwedd was created from many of these things.

ANSWER: a flower stalk [or a grass flower]

6. This identity category can be exposed as a social construct via parodies, such as dressing in drag, according to a book about its namesake *Trouble* by Judith Butler. For 10 points each:

[10] Name this identity category, a set of social roles put on people based on their biological sex.

ANSWER: gender role

[10] Butler argued that gender had this quality, by which gender roles are created by repeated patterns of outwardly-visible action. Per Butler, this property of gender becomes visible in drag shows.

ANSWER: performativity [or being performative; accept answers such as "it is performed" or "people perform gender"; prompt on synonyms such as "acted"]

[10] This concept, discussed by contemporary gender theorist Julia Kristeva in *The Powers of Horror*, is the space between, or loss of distinction between, subject and other. It is outside the symbolic order.

ANSWER: abjection [or the abject]

7. According to Livy, this man stopped Spurius Maelius from using a grain shortage to try and become king. For 10 points each:

[10] Name this former Roman consul who was called on to save an army trapped on Mount Algidus by the Aequi in 458 BCE.

ANSWER: Lucius Quinctus Cincinnatus

[10] Before leaving to fight, Cincinnatus was named to this position, which he ended up holding for only sixteen days. This position with absolute authority was generally only used during times of crisis.

ANSWER: dictator

[10] Following his time as dictator, Cincinnatus went back to this occupation, which was what he was doing when a delegation from the Senate found him to ask him to become dictator.

ANSWER: farming [accept equivalent answers]

8. A man in this film breaks a store window to steal a woman's hat. For 10 points each:

[10] Name this nearly real-time Western film in which marshal Will Kane marries a Quaker and then must face a gang led by pardoned murderer Frank Miller.

ANSWER: High Noon

[10] This Austrian-American directed *High Noon*. He told the story of three soldiers stationed in Hawaii before the Pearl Harbor attack in *From Here to Eternity*.

ANSWER: Fred Zinnemann

[10] This actress received an Academy Award nomination for her performance in Zinnemann's *The Nun's Story*. She also starred in *Breakfast at Tiffany's* and *Roman Holiday*.

ANSWER: Audrey Hepburn [prompt on "Hepburn"]

9. The three hundred and ten of these zones make up 2.3% of the land of the United States, and many were formed under the 1934 Wheeler-Howard Act. For 10 points each:

[10] Name these areas that include Red Lake in Minnesota, Standing Rock in South Dakota, and Wind River in Wyoming.

ANSWER: American Indian reservations [or Native American reservations]

[10] America's largest reservation, Navajo Nation, includes this point where Colorado, New Mexico, Arizona, and Utah meet.

ANSWER: the Four Corners

[10] The Flathead Indian Reservation is found near this state's town of Kalispell. This state is home to the Bitterroot-Salish and Blackfoot tribes.

ANSWER: Montana

10. This party established the Economic Development Board in 1961, which was advised for twenty-three years by the Dutchman Albert Winsemius. For 10 points each:

[10] Name this political party that was formed in 1954 by Lee Kuan Yew, and which has been in power since 1959.

ANSWER: **People's Action Party** [or **PAP**]

[10] The PAP is a party in this Southeast Asian country, which separated from Malaysia in 1965. Its namesake capital city was founded in 1819 by Stamford Raffles.

ANSWER: Republic of **Singapore**

[10] In 1992, this substance's sale in Singapore was banned after it caused problems for the Mass Rapid Transit system. In 2004, that ban was relaxed, allowing approved forms of this substance to be prescribed by dentists.

ANSWER: chewing **gum**

11. This theory predicts the paramagnetic behavior of oxygen. For 10 points each:

[10] Name this theory which proposes that atomic orbitals can combine constructively and destructively to form bonding and antibonding orbitals delocalized over an entire compound.

ANSWER: **molecular orbital** theory [or **MO** theory]

[10] The simplest molecule, and the only one which has wavefunctions which can be solved exactly, is this one, consisting of two protons and an electron. It can be reduced from the three-body problem if the nuclei are stationary.

ANSWER: **dihydrogen cation** [or **H<sub>2</sub><sup>+</sup>**; or **hydrogen molecular ion**; don't accept or prompt on just "hydrogen" or "H<sub>2</sub>"]

[10] For more complex systems, to account for electron correlation, this post-Hartree-Fock method considers virtual orbitals from excited states and uses a variational approach to give the minimum energy for electronic wavefunctions.

ANSWER: **configuration interaction** [or **CI**]

12. In a 1999 study, researchers tested this bias by asking two groups how old Gandhi was when he died while telling one group he was older than 9 and another group that he was younger than 140. For 10 points each:

[10] Name this cognitive bias which suggests people will latch onto the first piece of information in making a decision, interpreting subsequent data around it.

ANSWER: **anchoring** [or **focalism**]

[10] Research into anchoring was pioneered by this psychologist who wrote *Thinking Fast and Slow* and developed prospect theory with Amos Tversky.

ANSWER: Daniel **Kahneman**

[10] Early in his career Kahneman showed that this body dilates more when people do more difficult tasks. This part of the eye is in the center of the iris and also dilates or contracts in response to certain drugs.

ANSWER: **pupil**

13. This novel ends with John Yossarian nearly being killed by Natelly's whore. For 10 points each:

[10] Name this war satire by Joseph Heller, set on the island of Pianosa.

ANSWER: **Catch-22**

[10] Joseph Heller was inspired by this novel about a seemingly incompetent soldier during World War I. It is the best known work of Czech author Jaroslav Hašek.

ANSWER: *The Fateful Adventures of the* **Good Soldier Švejk** *During the World War* [or **Osudy dobrého vojáka Švejka za světové války**]

[10] In *The Good Soldier Švejk*, the title character lives his civilian life before the war as a dealer in these animals. Another character, Bretschneider, is eaten by these animals.

ANSWER: stolen **dogs**

14. In one limit, this potential reduces to the particle-in-a-box potential, while in another, it reduces to a delta well. For 10 points each:

[10] Identify this quantum-mechanical potential whose bound states are sinusoids stitched to exponentials. A one-dimensional lattice of this potential is equivalent to the Kronig-Penney model, which models crystalline solids.

ANSWER: (one-dimensional) finite **square** (potential) well [or finite **rectangular** well; accept **finite potential well**; prompt on any partial answer; do not accept or prompt on any answer containing "infinite"]

[10] The Kronig-Penney model is easily solved via Bloch's theorem, which states that an energy eigenfunction in a potential of this type can be decomposed into the product of an exponential and a function of this type.

ANSWER: **periodic** potential [or **periodic** function]

[10] The exponential term in a Bloch wave depends on the wavevector  $k$ , which multiplies  $\hbar$  to give a "crystal" form of this quantity useful in describing the behavior of electrons. By the uncertainty principle, one cannot

simultaneously know position and this quantity.

ANSWER: linear **momentum**

15. This man was a pupil of Lucas Cranach the Elder and painted several works housed in St. Florian's Priory. For 10 points each:

[10] Name this German artist of *Landscape with a Footbridge*, whose most famous work was commissioned by Duke William IV.

ANSWER: Albrecht **Altdorfer**

[10] Duke William IV commissioned *The Battle of Issus*, which depicts this leader defeating the Persians led by Darius III.

ANSWER: **Alexander the Great** [or **Alexander III** of Macedon]

[10] Altdorfer also made a version of this scene, which is depicted on the central panel of the Mérode Altarpiece. Other famous versions of this scene include one by Fra Angelico and the Cestello one by Botticelli.

ANSWER: **Annunciation** to the Blessed Virgin Mary

16. Participants in this event perform *rami al-jamarat*, an observance which involves throwing seven stones at walls to represent defiance of the devil. For 10 points each:

[10] Name this pilgrimage to Mecca, which is mandatory for all healthy Muslims at least once in life. It occurs during the twelfth month of the Islamic calendar.

ANSWER: **hajj**

[10] This cathedral in Galicia is named for the apostle and patron saint of Spain whose bones are interred there. A medieval pilgrimage route to this church was marked by scallop shells.

ANSWER: Cathedral of **Santiago de Compostela** [or Catedral de **Santiago de Compostela**; prompt on "Santiago," "St. James", or "Compostela" alone]

[10] Buddhist pilgrims often visit Lumbini, Nepal, the alleged site of this event.

ANSWER: **birth** of Gautama **Buddha** [or **birth** of **Shakyamuni**; or **birth** of Siddhartha **Gautama**; prompt on "the Buddha's childhood" and similar answers]

17. As governor of the Louisiana Territory, this man, despite his own involvement in the plotting, exposed a plan that would have attempted to put western territories under the rule of a former vice president. For 10 points each:

[10] Name this man whom Frederick Jackson Turner called "the most consummate artist in treason the nation has ever possessed." This man was called Agent 13 during his involvement in the Spanish Conspiracy.

ANSWER: James **Wilkinson**

[10] Part of the Spanish Conspiracy was Wilkinson's attempt to get this state to join Spain to open trade down the Mississippi. At the time, it was the western part of Virginia, from which it separated to become a new state in 1792.

ANSWER: Commonwealth of **Kentucky**

[10] Wilkinson exposed this man's conspiracy in 1806, although this man was acquitted for lack of overt action in his treason trial. In 1804 while serving as vice president, he had been more overt in killing Alexander Hamilton.

ANSWER: Aaron **Burr**

18. Name these tellers of Canterbury Tales, for 10 points each.

[10] This author of *The Canterbury Tales* incorporated a fictionalized version of himself into the frame narrative. He starts to tell the story of Sir Thopas, but is stopped by Harry Bailey, who considers it "not worth a turd."

ANSWER: Geoffrey **Chaucer**

[10] This character tells the story of Chanticleer the rooster, who is caught by a fox but manages to trick him into opening his mouth and dropping him.

ANSWER: the **Nun's Priest**

[10] This man and his master catch up with the rest of the pilgrims at Boughton-under-Blean. He tells of his master's alchemical pursuits, and of an even more devious alchemist who pretends to turn quicksilver into silver.

ANSWER: the Canon's **Yeoman**

19. This supervised-learning problem may be solved using decision trees. For 10 points each:

[10] Name this problem in machine-learning, the goal of which is to identify the subpopulation to which a given observation belongs. Discriminant analysis is sometimes used for this task.

ANSWER: **classification** [or word forms]



[10] Classification with only two groups can take the form of binary regression, and thus can be solved using this generalized linear model, which has binomial errors, and reports predictions in the form of log odds.

ANSWER: **logistic** regression [or **logit** regression]

[10] By contrast, the errors in ordinary linear regression models are assumed to follow this distribution. For IID random variables with finite variance and a well-defined mean, the sample mean converges in distribution to this distribution, per the central limit theorem.

ANSWER: **normal** distribution [or **Gaussian** distribution]

20. This ruler was served by the prime minister Leopoldo O'Donnell, who captured Tetuan during the Spanish-Moroccan War. For 10 points each:

[10] Name this ruler who, along with her younger sister, was involved in the Affair of the Spanish Marriages when she was married to a French prince.

ANSWER: **Isabella II** of Spain [prompt on "Isabella"]

[10] Isabella's rule was contested by her uncle in the first of these wars that occurred in nineteenth century Spain. The last of these wars started in 1872, four years after Isabella was deposed from the throne.

ANSWER: **Carlist** Wars

[10] Isabella and her husband were both members of the House of Bourbon, which led Lord Palmerston to claim that the marriage broke this 1713 treaty that ended the War of the Spanish Succession.

ANSWER: Peace of **Utrecht**

21. This city is situated at the confluence of the Negro and Solimoes Rivers and contains Eduardo Gomes International Airport. For 10 points each:

[10] Name this seventh most populous city of Brazil, the only 2014 World Cup Site to be situated in the rainforest.

ANSWER: **Manaus**

[10] Manaus is the capital of the state named after this longest river of South America. Its source is near Iquitos, Peru and it flows into the Atlantic Ocean.

ANSWER: **Amazon** River

[10] At the mouth of the Amazon River lies this island located in the Brazilian state of Para. It is the world's largest island surrounded entirely by freshwater.

ANSWER: **Marajo** Island