Physics lightning.

1. PHYSICS: *Short Answer:* If g=10 m/s2, how long must a pendulum be to have a period of 1 second? Give your answer as a rational fraction in terms of pi.

ANSWER: 5/2π2 m

2. PHYSICS: *Short Answer:* A ball is thrown upwards with an initial speed of 5 m/s. If g=10 m/s2, what is the maximum height the ball will reach?

ANSWER: 1 meter

3. PHYSICS: *Multiple Choice:*  A beam of light is incident on a still pond at the polarizing angle, θp. Which of the following statements is true regarding the reflected and refracted light?  
  
W) the reflected light is completely polarized perpendicular to the plane of incidence, and the refracted light is completely polarized perpendicular to the plane of incidence

X) the reflected light is completely polarized perpendicular to the plane of incidence, and the refracted light is partially polarized parallel to the plane of incidence

Y) the reflected light is partially polarized perpendicular to the plane of incidence, and the refracted light is completely polarized perpendicular to the plane of incidence

Z) the reflected light is partially polarized parallel to the plane of incidence, and the refracted light is partially polarized parallel to the plane of incidence

ANSWER: X) the reflected light is completely polarized perpendicular to the plane of incidence, and the refracted light is partially polarized parallel to the plane of incidence

4. PHYSICS: *Short Answer:* What thermodynamic potential measures the work extractable from a thermodynamic process that is both isothermal and isochoric, and is commonly used in reactions which induce pressure changes, such as explosives, in which Gibbs free energy would be inapplicable?

ANSWER: Helmholtz free energy

5. PHYSICS: *Short Answer:* What geometrical method is used to find the shape of a wave front by treating every point on it as a source of secondary wavelets which spread out in all directions with a speed equal to the speed of propagation of the original wave?

ANSWER: Huygen's principle

6. PHYSICS: *Multiple Choice:* Which of the following statements best describes the image and location of the image formed when an object is placed between the center of curvature and the focal length of a converging mirror?

W) real and inverted; beyond the center of curvature

X) real and inverted; between the mirror and the focal point

Y) real and inverted; between the focal point and mirror surface

Z) virtual and upright; behind the mirror

ANSWER: W) real and inverted; beyond the center of curvature  
  
7. PHYSICS: *Short Answer:* By name or number, denote all of the following four statements which is or are true regarding mirrors:

1. spherical mirrors cannot form precise point images of a point object due to spherical aberration

2. if the radius of a spherical mirror is known, the focal length can be calculated by halving the radius

3. diverging mirrors always form a virtual image that is larger than the object

4. a perfectly-shaped parabolic mirror should not experience any aberration whatsoever

ANSWER: 1 and 2

8. PHYSICS: *Short Answer:* By name or number, denote all of the following three statements which is or are true of a thin lens:  
  
1. an incident ray passing through the center of the lens will not experience any refraction

2. an incident ray passing through the focal point of the lens will emerge parallel to the optic axis  
3. an incident ray that is parallel to the optic axis will pass through the focal point

9. PHYSICS: *Multiple Choice:* Which of the following statements is not true based on Einstein's theories of relativity?  
  
W) objects which are in motion experience some measure of time dilation

X) as an object approaches the speed of light, c, its relativistic momentum approaches infinity

Y) an object that is shorter due to length contraction is actually physically shorter than its proper length

Z) lengths measured perpendicular to the direction of motion of an object also experience length contraction

ANSWER: Z) lengths measured perpendicular to the direction of motion of an object also experience length contraction

10. PHYSICS: *Short Answer:* Name two of the three series that correspond to transitions of electrons in a hydrogen atom which emit infrared radiation.

ANSWER: Paschen, Brackett, Pfund

11. PHYSICS: *Short Answer:* What process do lasers use to produce coherent radiation by using photons to induce exited atoms to emit more photons with the same frequency, direction, phase, and polarization as the original photon?

ANSWER: stimulated emission

12. PHYSICS: *Multiple Choice:* What phenomenon, whose explanation in 1923 provided direct confirmation of the quantum nature of X rays, involved scattered X rays having smaller frequency than the incident radiation which was dependent on the angle of the scattered radiation?  
  
W) Rayleigh scattering

X) Espresso crema effect  
Y) Compton scattering

Z) Brillouin scattering

ANSWER: Y) Compton scattering

13. PHYSICS: *Multiple Choice:* Which of the following substances could not produce a continuous spectrum?  
  
W) a solid

X) a liquid

Y) a gas with high density

Z) a gas with low density  
  
ANSWER: Z) a gas with low density

14. PHYSICS: *Short Answer:* Calculate the change in entropy when 100 Joules of heat are added to a system at 300K.  
  
ANSWER: 1/3 J/K  
  
15. PHYSICS: *Short Answer:* In 1936, scientist looking for the recently-proposed pion, found a track in a cloud chamber that matched the theoretical track of the pion. However, it was discovered that the particle was slightly lighter than expected and, while having both positive and negative versions, did not have a neutral version, as the pion should. Give the name of this particle, and classify it as either a quark, lepton, or boson.  
  
ANSWER: muon, lepton

16. PHYSICS: *Multiple Choice:* Which of the following statements best describes why early neutrino detectors were only able to detect a fraction of the expected neutrinos?  
  
W) the detectors were meant to interact with the neutrinos coming from the sun, the amount of which scientists overestimated

X) neutrinos can oscillate in flight, and early detectors could only detect one flavor of neutrino

Y) the detectors were at ground level, allowing solar neutrinos to be blocked by the atmosphere

Z) during that period, the sun was going through a cycle of low neutrino production

ANSWER: X) neutrinos can oscillate in flight, and early detectors could only detect one flavor of neutrino

17. PHYSICS: *Short Answer:* At what detector of the Large Hadron Collider are lead nuclei collided in order to generate and study quark-gluon plasmas?  
  
ANSWER: ALICE

18. PHYSICS: *Short Answer:* In 1953, what property of matter which is always conserved was invented in order to rationalize the production of certain particles produced by the interaction of high-energy pions and atomic nuclei? These so called "strange" particles are always produced in pairs, and include electrically charged and neutral kaons.

ANSWER: strangeness

19. PHYSICS: *Multiple Choice:* Which of the following particles does not undergo decay?  
  
W) strange quark

X) charm quark

Y) up quark

Z) bottom quark  
  
ANSWER: Y) up quark

20. PHYSICS: *Multiple Choice:* Which of the following statements describes the composition of a proton?  
  
W) two up quarks and one down quark

X) one up quark and two down quarks

Y) one up quark and one down quark

Z) three up quarks

ANSWER: W) two up quarks and one down quark

21. PHYSICS: *Multiple Choice:* Which of the following statements describes the composition of a positively-charged pion?  
  
W) one up quark and one antiup quark

X) one up quark and one antidown quark

Y) one down quark and one antidown quark

Z) one down quark and one antiup quark

ANSWER: X) one up quark and one antidown quark

22. PHYSICS: *Short Answer:* The fundamental of a standing wave is 1337 Hz. Calculate the frequency of the second overtone.

ANSWER: 4011 Hz

23. PHYSICS: *Multiple Choice:* Jack and Jill are on a merry-go round. Jack stands one meter from the center of the merry-go round, while Jane stands 2 meters from the center. Assuming that the two are of equal weight, which of the following statements is true?  
  
W) Jane's centripetal acceleration is greater than Jack's

X) Jack's angular velocity is greater than Jane's

Y) Jack travels a farther distance than Jane on each rotation of the merry-go-round

Z) Jack's linear velocity is greater than Jane's

ANSWER: Z) Jack's linear velocity is greater than Jane's

24. PHYSICS: *Short Answer:* What device currently being developed by HP increases or decreases the electrical resistance based on the direction of current flow?  
  
ANSWER: memristor

# 25. PHYSICS: *Short Answer:* Which scientist won the first-ever Nobel Prize in physics in 1901 for his production and identification of X-rays? ANSWER: Wilhelm Röntgn