Honors 202-2 Review Questions for Units 4-7

You should be able to answer the following questions. For some questions, I have given (in parentheses) the main ideas I expect you to understand. Most of the other questions can be answered through the text, class notes, and lecture slides (http://physics.byu.edu/rees/202.htm).

On the test, I will not ask strictly biographical questions or dates. (Where was Einstein born? When did the World War I end?) However, you should be familiar with historical events, characteristics of the society, etc., as typified by the questions below.

The test will NOT be comprehensive.

1. What is meant by normal science? What scientific revolutions occurred after the time of Newton?

2. What parallels are there between scientific revolutions and the Restoration (the beginnings of the LDS Church)? If you would prefer, you may discuss the Reformation instead of the Restoration. (Characteristics of the people involved, necessity of reformulating paradigms, difficulty in getting established, etc.)

3. Why does Thomas Kuhn argue that Newtonian mechanics cannot truly be derived from relativistic mechanics? What do we really mean by the Correspondence Principle, then? The Correspondence Principle says that new theories must mathematically reduce to the old theories in the appropriate limits. Kuhn argues that the new theories change our understanding of fundamental ideas (such as mass). The equations of the old theory survive, but the ideas of the new theory are established.

4. What was the significance of Thomas Young’s experiment?

5. What are the four main characteristics of caloric?
   - Caloric repels other caloric.
   - Caloric sticks to ordinary matter.
   - Caloric can be forced out of hot matter.
   - Only free caloric produces a rise of temperature.

6. How are experimental observations about heat explained by caloric theory?
   1. Heat is conducted from hot objects to cold objects. Caloric in the hot object repels other caloric and forces some into the cold object.
   2. Hot objects expand. More caloric attached to the particles of a hot object makes it larger.
   3. Friction increases temperature. Friction causes bound caloric to be knocked off matter, so the temperature rises.
   4. Heat is radiated from the sun. The sun has so much caloric, some is forced off and repelled through space to the earth.
   5. Hot solids melt, hot liquids boil. When enough caloric sticks to matter, it forces the particles of matter so far apart that the form changes.

7. What were the contributions of Thomson (Count Rumford), Leibniz, Mayer, and Joule to our understanding of energy?

8. What is meant by Ockham’s Razor? How does this relate to Heisenberg’s version of quantum mechanics vs. Schrödinger’s version of quantum mechanics? "That is best that is simplest and works."

9. Describe Fermat’s Law. How is this an application of an extremum principle?
10. Describe Maxwell’s Equations in words.

- Spreading electric fields are produced by electric charges.
- Spreading magnetic fields do not exist.
- Looping electric fields are produced by magnetic fields that change in time.
- Looping magnetic fields are produced by electric fields that change in time or by electric currents.

11. In what ways have physicists attempted to remove the necessity for action at a distance that seemed to be required by Newton’s Laws?

Fields (the electromagnetic approach), modification of the curvature of space-time (the general relativistic approach), exchange of virtual particles (the quantum mechanical approach).

12. Describe Franklin’s one fluid model of electricity.

1. Electric fluid fills ordinary matter.
2. Glass easily accepts additional electric fluid when rubbed by silk, so it becomes "positive."
3. The silk loses electrical fluid, so it becomes "negative."
4. Electric fluid repels other electric fluid and attracts ordinary matter.
5. Metal has channels to allow electric fluid to flow in it. (Caloric flows through these same channels, but not as fast.)
6. Electric fluid remains stationary on insulators. (Caloric flows slowly through insulators.)


1. Fields are made of filaments in space. The filaments are called "field lines" or "lines of force."
2. Magnetic field lines can be traced with iron filings. Electric field lines can be traced with grass seeds in oil.
3. Energy is stored in field lines. Field lines want to become as short as possible to minimize energy.
4. On the other hand, field lines repel each other. Field lines want to stay as far apart from each other as possible.
5. Charges and field lines transfer force to each other.
6. Field lines transfer force to other field lines.
7. Action at a distance is unnecessary because forces are transferred by field lines.
8. When a wire cuts magnetic field lines, electricity "bleeds" out of the field lines.

14. Briefly describe Maxwell’s idea of fields (idle wheels and vortices.)

1. Forces are transferred by an elastic medium called the aether.
2. An electric charge causes a displacement of the charges in the aether.
3. Displaced charges in the aether in turn cause forces on other charges.
4. Moving charges cause the vortices to rotate. The rotating vortices are the magnetic fields.
5. The vortices and idle wheels interact to produce displacement current, induced electric fields, etc.

15. Briefly describe statistical mechanics.

16. How did the work of Michelson and Lorentz contribute to the advent of special relativity?

17. What are the two postulates of special relativity?

18. What are some consequences of special relativity?

Simultaneity is relative.
Moving objects are contracted in the direction of motion.
Moving clocks run slowly.
Moving objects have increased inertia ("mass").
Objects have a rest energy.
The rest mass of objects can be converted to energy, and mass can be created out of energy.

19. Briefly describe how blackbody radiation and the photoelectric effect led to the advent of quantum mechanics.
20. What is the deBroglie relationship? How was it significant in leading Schrödinger to the formation of wave mechanics?

21. In what ways were Bohr’s model of the atom incorrect? What were its successes?
*Electron orbits instead of orbitals, improper quantization of angular momentum. Correct energy levels and therefore correct emission spectrum.*

22. What are the fundamental postulates of quantum mechanics?
1. For every physical observable, there exists an operator.
2. For every physical state of a system, there exists a "state function."
3. Measurement of a physical observable forces the system into a state described by a fixed value of the observable.

23. In what way does a quantum mechanical operator model the measurement of a physical observable?
*Measurement of physical observables and the action of quantum mechanical operators both modify the state of a system.*

24. Briefly describe how Erwin Schrödinger constructed his wave equation.

25. Sketch the wavefunctions which are allowed in an infinitely deep (one-dimensional) potential well. What is the probability of finding a particle as a function of position for each of these wavefunctions. Describe how the wavefunctions lead to quantization of energy.

26. What is meant by quantum mechanical tunneling?

27. What do the following equations represent?
\[
\frac{\hbar}{2} \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} = \frac{\hbar}{2} \begin{pmatrix} 1 \\ 0 \end{pmatrix}
\]
\[
\frac{\hbar}{2} \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \begin{pmatrix} 0 \\ 1 \end{pmatrix} = -\frac{\hbar}{2} \begin{pmatrix} 0 \\ 1 \end{pmatrix}
\]

28. How do commutators relate to the Heisenberg Uncertainty Principle?

29. What is meant by the Principle of Complementarity?

30. What is the Principle of Equivalence? How does it apply to light bending in a gravitational field?

31. Describe why there is a gravitational red shift.

32. What two evidences of a big bang are associated with red shifts?

33. How does the Dirac Sea explain the existence of positrons?
*Dirac proposed that negative energy states were full of electrons.
Sea electrons cannot interact without jumping out of the sea, as all sea states are already filled.
A photon with enough energy could knock an electron out of the sea, creating an electron and leaving a hole. The hole would appear like a positive electron.*
34. What do the following diagrams mean? What interaction is involved? What is occurring in each diagram? What are the W and Z?

![Diagram](https://via.placeholder.com/150)

35. What is the quark composition (flavor and color) of baryons, antibaryons, and mesons?
3 quarks: red, green, blue. 3 antiquarks: antired, antigreen, antiblue. Quark and antiquark: red-antired, green-antigreen, or blue-antiblue.

36. Quarks have fractional charge. Have we ever detected a particle with fractional charge? Why or why not?

37. Protons and neutrons are often described in terms of a quark “bag model.” What does this mean and why does it work? Explain your answer in terms of gluons and QCD.

38. What were some of the philosophies current in the 18th and early 19th centuries that led to revolutions in places such as France and the American colonies of Spain and England?

39. What were some of the positive results of Napoleon’s rule?

40. Do you feel that the industrial revolution led to the establishment of large totalitarian states in Europe in the 20th century? Discuss your answer.

41. Did women gain or lose power in society as they moved to urban settings in the 19th century? Support your ideas.

42. The revival of Greco-Roman thought led to many of the artistic ideals of the neo-Classical era. How would the work of Mozart be considered as typical of this movement?

43. What elements of Beethoven’s music made him immensely popular through most of the 19th and all of the 20th century?

44. Name two neo-Classical artists. Describe some of the main characteristics of visual art in this period.

45. Romanticism has been defined as a reaction against forms and rules. With this in mind, compare the music of the classical and romantic periods.

46. Name a writer of the romantic period. Describe what was significant about his/her work.

47. Name one romantic composer closely associated with each of the following musical forms: symphony, opera, piano composition.
48. Briefly describe some of the major problems associated with cities in the 19th century. Why was burial such a problem in 19th century cities? Why hadn’t burial problems been resolved in realier times?

49. Describe one attempt at social reform that went awry. Was it generally true that public works did more damage than good in 19th century urban areas?

50. What long-lasting effects did the global depression of the 1930's have on world history?

51. What are some important ways that physics has affected 20th century society? Give both positive and negative examples.

52. Has the rethinking of traditional values in the 20th century led to a society that is devoid of values? Defend your position.

53. Will 20th century “pop culture” be studied in the 22nd century? Why or why not? (Note: “No, because we’ll have better things to do during the millennium,” while possibly true, will not be worth many points.)

54. What is impressionism? Who were two impressionist artist and two impressionist painters? What was similar about impressionist artwork and painting?

55. What were similarities and differences between impressionism and expressionism?

56. Name an artist associated with each of the following: expressionism, cubism, surrealism, abstraction.

57. What are some of the important characteristics of 20th century music?

58. Of the 20th century music we listened to in class, what was your favorite. Describe some characteristics of this music. Why did you enjoy it?

59. What is the “twelve tone row”? What composer is most closely associated with it. What characteristics of 20th century music does his works typify?

60. From your experience, how would compare American composers and Russian composers of the 20th century?

61. Name a 20th century composer who used folk music extensively in his/her works. Briefly discuss the characteristics of this composer’s works.

62. How did the two world wars affect the arts?

63. Name a 20th century artist you do not like. What is the artist trying to convey through hi/her work? Why do you feel that you don’t relate well to their art?