DOCUMENT RESUME

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ABSTRACT

This document is an evaluation instrument developed as a part of Harvard Project Physics (HPP). It consists of a 36-item, multiple choice (five options) Physics Achievement Test (PAT) designed to measure general knowledge of physics as well as the material emphasized in HPP. (PEB)

PHYSICS ACHIEVEMENT TEST

To the student:

The test you are about to take is composed of a number of questions about physics. It is not intended to be a measure of your knowledge of Harvard Project Physics. Rather, we would like to know how much general physics you understand before taking this course so that we can trace your progress throughout the term.

Directions

Each of the 36 items in this test has five possible responses. You are to select the one response which best answers the question and blacken the appropriate space on the answer sheet provided with the test.

You will have 40 minutes. You will make your best score by answering every question. Work carefully, but do not spend too much time on any one question.

If you make a mistake, or wish to change an answer, erase your first mark completely. Do not make any stray marks on the answer sheet. They may count against you. Note carefully the way the answer sheet is numbered.

Sample question

0. Which of the following is a city?

A. San Francisco
B. England
C. Wisconsin
D. Mississippi
E. Yale

Because the correct answer is "San Francisco", blacken space A on the answer sheet.

0. A B C D E

Do not turn the page until told to do so.

1. An isotope of carbon can be represented by the symbol $_6C^{13}$. How many electrons are there in a neutral atom of this isotope?

   A. 0

   B. 6

   C. 7

   D. 13

   E. 19

2. Which one of the following terms would have appeared in the physics literature before 1900?

   A. neutron

   B. isotope

   C. atom

   D. cyclotron

   E. fission

3. Nuclear reactors are being built in populated areas. There is little likelihood of a nuclear explosion because

   A. less uranium is used than in a nuclear bomb.

   B. the reactors contain moderators which slow down the neutrons.

   C. the number of free neutrons is controlled by an absorbing material.

   D. a nonradioactive isotope of uranium is used.

   E. the reactor is above the critical size.

4. The chemical properties of an atom are determined by its

   A. mass number.

   B. number of isotopes.

   C. mass defect.

   D. atomic number.

   E. nuclear binding energy.

5. Imagine that a new particle, the y particle, is discovered among the radiations emitted by certain radioactive elements. The y particle is found to have an atomic number of 3 and a mass number of 5. Which one of the following nuclear equations describes the emission of a y particle from a $_{94}Pu^{239}$ nucleus?

A. $_{94}Pu^{239} \longrightarrow {}_{3}y^{5} + {}_{91}Pa^{234}$

B. $_{94}Pu^{239} \longrightarrow {}_{3}y^{5} + {}_{97}Bk^{244}$

C. $_{94}Pu^{239} \longrightarrow {}_{3}y^{5} + {}_{91}Pa^{244}$

D. $_{94}Pu^{239} \longrightarrow {}_{5}y^{3} + {}_{89}Ac^{236}$

E. $_{94}Pu^{239} \longrightarrow {}_{5}y^{3} + {}_{91}Pa^{234}$

6. All EXCEPT one of the following particles may be used as a projectile in particle accelerators. Find the exception.

A. electron

B. proton

C. neutron

D. alpha particle

E. deuteron ($_{1}H^{2}$ nucleus)

7. Which one of the following is a vector quantity?

A. force

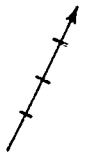
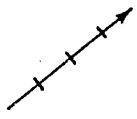
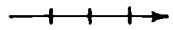
B. energy

C. speed

D. mass

E. time

8. The following vectors represent the velocity of a Boeing 707 jet at three consecutive times:

t_1:  t_2:  t_3: 

we may conclude that the jet is

A. speeding up.

B. slowing down.

C. changing direction.

D. at rest.

E. maintaining a constant velocity.

9. A satellite is moving in uniform circular motion about the earth. Which of the following statements must be true regarding the satellite's motion?

I. The speed is constant.

II. The velocity is constant.

III. The speed is varying.

IV. The velocity is varying.

A. I only.

B. II only.

C. I and IV only.

D. II and III only.

E. Some other combination of I, II, III, and IV.

10. This test booklet is resting on your desk. Which of the following statements applies most nearly to this situation?

A. There are no forces acting on your booklet.

B. Your booklet is at rest in any coordinate system.

C. Your booklet exerts no force on the desk.

D. Your booklet is accelerated toward the earth at 9.8 meters/sec^2.

E. There are many forces acting on your booklet, but they balance each other.

11. All EXCEPT one of the following men lived during the 1600's. Which one is the exception?

A. Galileo

B. Shakespeare

C. Rembrandt

D. Kepler

E. Napoleon

12. A boy stands in the middle of an enclosed trailer which is pulled by a truck moving along a straight line at constant speed. He jumps vertically into the air and then falls back toward the floor. Where will he land?

A. Behind the middle of the trailer, the distance depending on the truck's speed.

B. Behind the middle of the trailer, the distance depending on how high he jumps.

C. Behind the middle of the trailer, the distance depending on both the truck's speed and how high he jumps.

D. At the middle of the trailer.

E. In front of the middle of the trailer.

13. To ancient observers, the principal difference between the planets and the stars was that the planets appeared

A. brighter.

B. more like the earth.

C. to wander among the other stars.

D. closer to the earth.

E. to travel around the sun.

14. Which of the following statements must be part of any heliocentric theory?

A. The planets revolve around the sun.

B. The sun is a sphere.

C. The earth is a sphere.

D. The planets revolve around the earth.

E. The earth turns on its axis.

15. A student is given a closed box containing an unknown object. After a few shakes of the box, the student is asked to make a guess as to what the object might be. In giving his answer he should be guided by all of the following principles EXCEPT one. Which one is the exception?

A. Properties common to objects in general should be properties of this one.

B. General physical laws will apply inside the box.

C. The guess should be justified by all observations made so far.

D. The guess should be capable of being tested by further experimentation.

E. If there are two good possibilities, the more complex guess will probably be the best.

16. Tycho Brahe made many contributions to science during his lifetime, particularly in the field of astronomy. His most important contribution was

A. the accurate observations of the positions of the stars and planets.

B. the discovery of a new star.

C. the founding of an astronomical observatory at Uraniborg.

D. his own theory of planetary motions.

E. his observations of a comet.

17. The equatorial bulge of the earth is thought to be due to

A. some cause which is as yet undiscovered.

B. the 26,000 year precession of the earth's axis.

C. the earth's rotation.

D. the gravitational pull of the moon.

E. the tilt of the earth's equatorial plane with respect to its orbital plane.

18. All EXCEPT one of the following statements are true. Which is the exception?

A. The earth is moving fastest when closest to the sun.

B. The path of the earth lies in a plane which passes through the sun.

C. A line drawn from the sun to the earth sweeps over the same area from March 21 to March 23 as it does from December 21 to December 23.

D. The sun is at the exact center of the earth's orbit.

E. The earth's path around the sun is an ellipse.

19. A girl lifts a bowling ball and places it on a rack. If you know the weight of the ball, what else would you need to know in order to calculate the work she did on the ball?

A. Mass of the ball.

B. Value of g.

C. Height of the rack.

D. The time required.

E. Nothing else.

20. Flask B contains a barometer that reads 50 cm of mercury. A vacuum exists in flask A. The volumes of the two flasks are equal. If valve Y between the flasks is opened, the reading on the barometer will be about

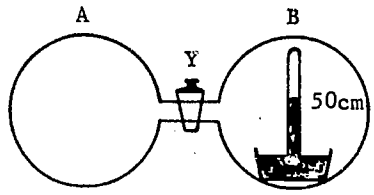
A. 0 cm.

B. 25 cm.

C. 50 cm.

D. 100 cm.

E. 200 cm.



21. The absolute temperature in the room where you are taking this test is approximately

A. 20° K.

B. 70° K.

C. 100° K.

D. 300° K.

E. 460° K.

22. Two spheres of the same diameter, one of mass 5 kg and the other of mass 10 kg, are dropped at the same time from the top of a tower. When they are 1.0 meter above the ground, the two spheres have the same

A. momentum.

B. kinetic energy.

C. potential energy.

D. total mechanical energy.

E. acceleration.

23. The kinetic energy of an object would be increased the most by doubling its

A. mass.

B. temperature.

C. volume.

D. density.

E. speed.

24. A 10-kg block of aluminum (specific heat = .22) initially at 40° C. is placed into 10 kg of water which has a temperature of 20° C. What is the final temperature of the water? (Assume there is no heat loss to the containing vessels or surroundings.)

A. Less than 20° C.

B. 20° C.

C. Between 20° and 40° C.

D. 40° C.

E. More than 40° C.

25. Arrange the following units of length in order of increasing magnitude.

1. one centimeter

2. one angstrom

3. one meter

The correct arrangement is:

A. 1,2,3.

B. 2,3,1.

C. 3,1,2.

D. 2,1,3.

E. 3,2,1.

26. Which of the following voices produces sounds in air with the longest wavelength?

A. alto

B. bass

C. baritone

D. soprano

E. tenor

27. In a vacuum, electromagnetic radiations such as radio waves, light, x rays, and gamma rays have the same

A. wavelength.

B. frequency.

C. period.

D. speed.

E. amplitude.

28. Even though one may listen to a band from a considerable distance, the melody and the accompaniment do not get "out of time" with each other. This is evidence that in this situation sound waves

A. of all frequencies travel at the same speed.

B. are not polarized.

C. are longitudinal.

D. tend to be sinusoidal.

E. travel at a slower speed than light.

29. All EXCEPT one of the following situations involves the use of electromagnetic radiation. Find the exception.

A. A movie is projected onto a screen.

B. The heat of a fireplace is felt across the room.

C. A doctor takes an x ray of your chest.

D. An echo is heard from across a lake.

E. A live television program is received from Europe via Telstar.

30. A wire hidden in the wall is carrying direct current. What piece of equipment might help you to find the location of the wire?

A. ammeter

B. voltmeter

C. magnetic compass

D. coil of wire

E. radio receiver

31. The apparatus shown in the sketch is used for the electrolysis of water. What is the object marked with an X?

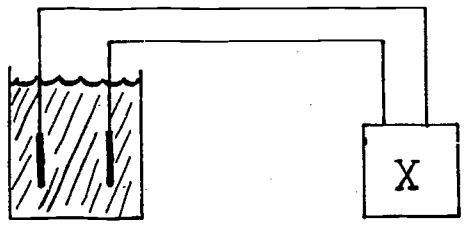
A. A container for the gases.

B. A battery.

C. A motor driven by the cell.

D. An unnecessary piece of equipment.

E. An electrode.



32. The electric charge of an electron can be increased by

A. increasing its momentum.

B. increasing its kinetic energy.

C. decreasing its de Broglie wavelength.

D. accelerating it to very high speeds.

E. None of the above processes will increase the charge of an electron.

33. The Rutherford scattering experiment is important because it

A. won the Nobel prize for Rutherford, the highest honor a scientist can receive.

B. supported the atomic model proposed by Thomson.

C. indicated the presence and approximate size of a central, electrically charged nucleus.

D. showed the reliance of technology upon science.

E. showed the importance of considering relativistic mass.

34. A substance, such as oxygen, can be discussed in terms of atoms, electrons, molecules, and nuclei. If these objects (as they refer to oxygen) are listed in order of decreasing mass, with the most massive first, which one of the following lists is correct?

A. electron, molecule, nucleus, atom.

B. molecule, nucleus, atom, electron.

C. nucleus, electron, molecule, atom.

D. molecule, atom, nucleus, electron.

E. atom, electron, nucleus, molecule.

35. Which of the following electromagnetic radiations has the most energetic photons?

A. radio

B. heat

C. visible light

D. ultraviolet

E. x ray

36. The Millikan oil drop experiment provided conclusive evidence that

A. electric charge is found as multiples of a certain unit of charge.

B. all electrons have a negative charge.

C. electrons are particles.

D. electrons have wave properties.

E. all atoms contain electrons.

(PAT) PHYSICS ACHIEVEMENT TEST