

# ANSWER SHEET

## Practice Test 1

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49. A B C D
50. A B C D



# AP Physics 2

## Practice Test 1

### SECTION I: MULTIPLE-CHOICE

**Time: 90 minutes**

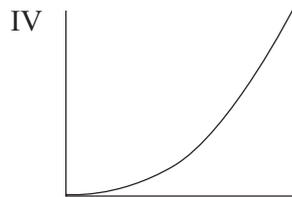
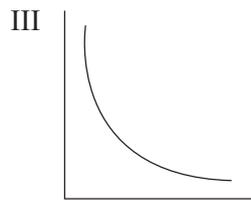
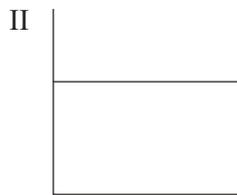
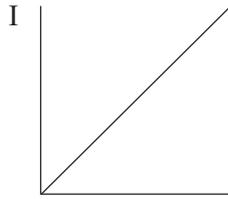
**50 questions**

**DIRECTIONS:** Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one (or two where indicated) that is best in each case. You have 90 minutes to complete this portion of the test. You may use a calculator and the information sheets provided in the appendix.

1. Which materials have the highest heat conductivity?
  - (A) Gases because the individual particles move the fastest
  - (B) Gases because they are the easiest to ionize
  - (C) Metals because they are ductile and malleable
  - (D) Metals because they have conduction layers
2. A gas is not able to do work under which of the following circumstances?
  - (A) Isobaric because pressure is required for work to be done
  - (B) Isobaric because constant force will produce no work
  - (C) Isochoric because constant shape implies no changes in energy
  - (D) Isochoric because no change in volume implies no displacement
3. Which of the following materials will exert the highest pressure on its bottom surface?
  - (A) 1 liter of water in a puddle on the ground
  - (B) 1 liter of water, frozen into a cube on the ground
  - (C) 1 liter of water in a tall, thin, vertical tube
  - (D) 1 liter of water, frozen into a cube, floating in liquid water

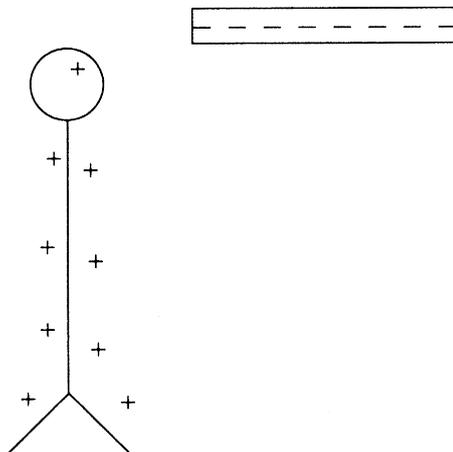
4. Heating up a gas by 100 degrees would require the least amount of energy if those degrees were
- (A) Kelvin since there are no negative Kelvin degrees
  - (B) Celsius since water boils at 100 degrees Celsius
  - (C) Kelvin since absolute zero is zero in Kelvin
  - (D) Fahrenheit since each of its degree changes are smaller than those in either the Celsius or Kelvin scales

QUESTIONS 5 AND 6 ARE BASED ON THE FOLLOWING GRAPHS:



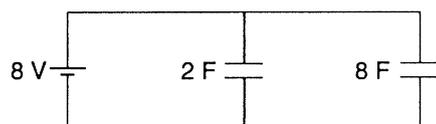
5. Which graph best represents the relationship between pressure and volume for an ideal confined gas at constant temperature?
- (A) I
  - (B) II
  - (C) III
  - (D) IV

6. Which graph best represents the relationship between the average kinetic energy of the molecules in an ideal gas and its absolute temperature?
- (A) I  
 (B) II  
 (C) III  
 (D) IV



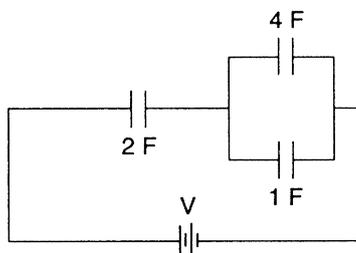
7. The diagram above shows a leaf electroscope that has been charged positively by a negatively charged rod. Which of the following statements is correct?
- (A) The electroscope was charged by conduction.  
 (B) The electroscope was charged by contact.  
 (C) If the rod is brought closer, protons will move to the top of the electroscope.  
 (D) If the rod is brought closer, electrons will be repelled from the top of the electroscope.

**QUESTIONS 8 AND 9 ARE BASED ON THE CIRCUIT SHOWN BELOW:**



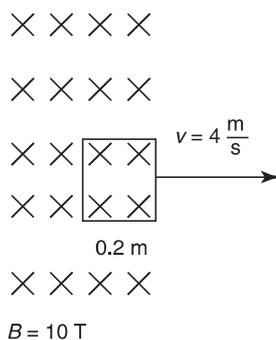
8. What is the maximum charge stored in the 2-farad capacitor?
- (A) 4 C  
 (B) 16 C  
 (C) 10 C  
 (D) 8 C

9. What is the maximum energy stored in the 8-farad capacitor?
- (A) 64 J  
 (B) 256 J  
 (C) 32 J  
 (D) 128 J



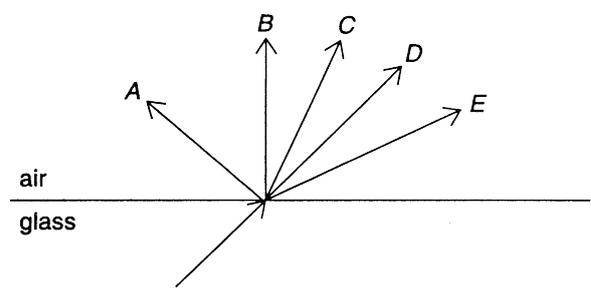
10. What is the equivalent capacitance of the circuit shown above?
- (A)  $7/10$  F  
 (B)  $10/7$  F  
 (C) 7 F  
 (D)  $14/5$  F
11. An electron (charge  $e$ , mass  $m$ ) is trapped in a circular path because of a uniform perpendicular magnetic field  $\mathbf{B}$ . The velocity of the electron is  $\mathbf{v}$ , and the radius of the path is  $r$ . Which of the following expressions represents the angular velocity  $\omega$ ?
- (A)  $(\mathbf{B}er/m)^{1/2}$   
 (B)  $(\mathbf{B}e/rm)^{1/2}$   
 (C)  $\mathbf{B}e/m$   
 (D)  $2\pi\mathbf{B}e/m$

QUESTIONS 12 AND 13 ARE BASED ON THE FOLLOWING INFORMATION AND DIAGRAM:



A square wire frame is pulled to the right with a velocity of 4 meters per second across and out of an inward uniform magnetic field of strength 10 teslas. The length of each side of the frame is 0.2 meter.

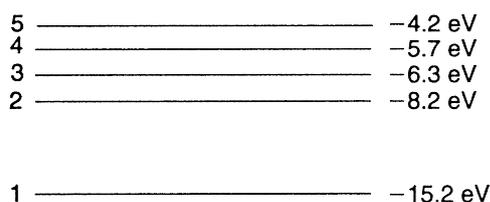
12. What is the magnitude of the induced motional electromotive force in the wire as it leaves the field?
- (A) 40 V  
 (B) 20 V  
 (C) 8 V  
 (D) 16 V
13. As the wire is moved to the right, a force appears to oppose it. This force's opposing direction is best explained by
- (A) Lenz's law because an opposing force keeps the flux from changing  
 (B) Faraday's law because the changing flux induces emf  
 (C) Lenz's law because the force must be in the negative direction  
 (D) Faraday's law since decreasing flux always produces negative forces
14. A shadow is formed by a point source of light. Upon closer inspection, the edges of the shadow seem to be diffuse and fuzzy. This phenomenon is probably caused by
- (A) dispersion as the different wavelengths of light focus at different points  
 (B) refraction as the rays are bent by their contact with the shadow-forming surface  
 (C) diffraction as the waves nearest the edge of the shadow-forming surface are sources for waves going into the shadow region  
 (D) dispersion as the different wavelengths are traveling at slightly different speeds in the new medium



15. A light ray is incident on a glass-air interface as shown above. Which path will the light ray follow after it enters the air?
- (A) A or B  
 (B) B or C  
 (C) E  
 (D) D
16. As the angle of incidence for a ray of light passing from glass to air increases, the critical angle of incidence for the glass
- (A) increases  
 (B) decreases  
 (C) increases and then decreases  
 (D) remains the same

17. Which of the following statements about a diverging mirror is correct?
- (A) The mirror must be concave in shape.
  - (B) The images are sometimes larger than the actual objects.
  - (C) The images are always upright.
  - (D) The images are sometimes real.
18. Which of the following waves cannot be polarized?
- (A) Sound waves because they are longitudinal
  - (B) Waves on a string because they lack amplitude
  - (C) X rays because they are too short
  - (D) Microwaves because they have too low of a frequency
19. The “flapping” of a flag in the wind is best explained using
- (A) Archimedes’ principle
  - (B) Bernoulli’s principle
  - (C) Newton’s principle
  - (D) Pascal’s principle
20. In a photoelectric effect experiment, the emitted electrons could be stopped with a retarding potential of 12 volts. What was the maximum kinetic energy of these electrons?
- (A)  $1.92 \times 10^{-18}$  J
  - (B) 12 J
  - (C)  $1.6 \times 10^{-19}$  eV
  - (D)  $1.92 \times 10^{-18}$  eV
21. As a single photon of light enters a new medium with a higher index of refraction, the photon’s energy
- (A) decreases as the wave speed is now lower
  - (B) decreases as its wavelength is now shorter
  - (C) remains constant because its speed is the same
  - (D) remains constant because its frequency remains the same
22. If an electron and an alpha particle were moving with the same velocity, which one would have the smaller de Broglie wavelength?
- (A) The electron since its charge is negative
  - (B) The electron since it has only one unit of elementary charge
  - (C) The alpha particle since it is heavier
  - (D) The alpha particle since it has two units of elementary charge

**QUESTIONS 23 AND 24 ARE BASED ON THE FOLLOWING SIMULATED ENERGY LEVEL DIAGRAM FOR A MYTHICAL HYDROGEN-LIKE ATOM:**

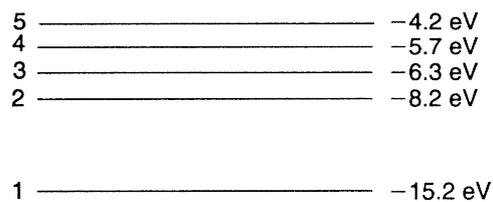


23. How much energy is required to ionize an atom with an electron in level 3?
- (A) 8.1 eV
  - (B) 6.3 eV
  - (C) 15.2 eV
  - (D) 2.5 eV
24. Which of the following level transitions will result in the emission of a photon with the highest frequency?
- (A) 1 to 3
  - (B) 5 to 2
  - (C) 1 to 2
  - (D) 2 to 1
25. One atomic mass unit is defined to be equal to
- (A) 1/2 the mass of a hydrogen molecule
  - (B) 1/12 the mass of the carbon atom
  - (C) 1/16 the mass of the oxygen atom
  - (D) the mass of an isolated proton
26. How many neutrons are contained in the isotope  ${}_{92}^{238}\text{U}$ ?
- (A) 92
  - (B) 100
  - (C) 146
  - (D) 330
27. In the reaction below, what is the mass number for particle X?
- $${}_{13}^{27}\text{Al} + {}_2^4\text{He} \rightarrow {}_{13}^{30}\text{P} + \text{X}$$
- (A) 1
  - (B) 2
  - (C) 0
  - (D) -1
28. A device that takes mechanical energy and converts it into electrical energy is
- (A) a solenoid
  - (B) an electric motor
  - (C) a transformer
  - (D) a generator
29. Radon gas ( ${}_{86}^{222}\text{Rn}$ ) is radioactive with a half-life of 4 days as it undergoes alpha decay. A sample is sealed in an evacuated tube for more than 1 week. At that time, the presence of a second gas is detected. This gas is most probably
- (A) hydrogen
  - (B) helium
  - (C) nitrogen
  - (D) argon

30. According to the scale of binding energy per nucleon, which atom has the most stable nuclear isotope?
- (A) Hydrogen because it cannot decay into anything
  - (B) Hydrogen because it can exist with only one nucleon
  - (C) Iron because its nucleons are the most tightly bound
  - (D) Iron because it is in the middle of the periodic table
31. The colors observed in thin films like soap bubbles are caused by
- (A) reflection and interference
  - (B) refraction and reflection
  - (C) diffraction and interference
  - (D) polarization and reflection
32. As the number of lines per cm on a diffraction grating is increased (or the slit spacing is decreased in a two-slit diffraction pattern),
- (A) the spacing between the spectral lines increases
  - (B) the spacing between the spectral lines decreases
  - (C) the intensity of the spectral lines increases
  - (D) the intensity of the spectral lines decreases
33. Which is storing more energy, a 20-microfarad capacitor charged up by a 6-volt source or a 10-microfarad capacitor charged up by a 12-volt source?
- (A) They both store the same amount of energy.
  - (B) Neither is storing energy.
  - (C) The 20-microfarad capacitor is storing more energy.
  - (D) The 10-microfarad capacitor is storing more energy.
34. What is the function of a moderator in a fission reactor?
- (A) Control the number of neutrons
  - (B) Act as a source of fissionable material
  - (C) Control the costs of running the reactor
  - (D) Control the half-life of the radioactive material
35. Compare the energy and speed of a 30 MHz photon with those of a 15 MHz photon.
- (A) They have the same speed and energy.
  - (B) The 30 MHz photon has higher speed and energy.
  - (C) The 30 MHz photon has higher energy but the same speed.
  - (D) The 30 MHz photon has lower energy but the same speed.
36. An electric motor has an effective resistance of 30 ohms, using 4 amperes of current when plugged into a 120-volt outlet. As the motor heats up, its effective resistance increases. Which statement best describes the power consumption of the motor?
- (A) It starts off at 480 W and goes down from there as  $4^2R$  as it heats up.
  - (B) It starts off at 480 W and goes up from there as  $4^2R$  as it heats up.
  - (C) It starts off at 480 W and goes down from there as  $120^2/R$  as it heats up.
  - (D) It starts off at 480 W and goes up from there as  $120^2/R$  as it heats up.

37. Which of the following correctly describes the magnetic field near a long, straight wire?
- (A) The field consists of straight lines perpendicular to the wire.
  - (B) The field consists of straight lines parallel to the wire.
  - (C) The field consists of radial lines originating from the wire.
  - (D) The field consists of concentric circles centered on the wire.
38. Electrons are being shot into a uniform magnetic field. The angles of the electrons' velocity vary as they are being shot. A magnetic force will be exerted on all electrons except those that are
- (A) perpendicular to the field
  - (B) parallel to the field
  - (C) at a  $45^\circ$  angle to the field
  - (D) either perpendicular or parallel to the field, depending on the strength of the field
39. On which of the following does the magnetic field inside a solenoid of  $N$  turns not depend?
- (A) The core material
  - (B) The length of the solenoid
  - (C) The radius of the solenoid
  - (D) The number of turns of wire
40. Which of the following statements about the adiabatic expansion of an ideal gas is correct?
- (A) The temperature may change during the expansion.
  - (B) The process must be isothermal.
  - (C) No change will occur in the internal energy.
  - (D) The gas cannot do any work during the expansion.
41. Which of the following processes is not involved in an ideal Carnot cycle?
- (A) Isothermal expansion
  - (B) Isobaric expansion
  - (C) Adiabatic expansion
  - (D) Adiabatic compression
42. A charged rod attracts a suspended pith ball. The ball remains in contact with the rod for a few seconds and then is visibly repelled. Which of the following statements must be correct?
- (A) The pith ball is negatively charged at the end of the process.
  - (B) The rod is negatively charged.
  - (C) The pith ball remained neutral throughout the process.
  - (D) The rod has less charge on it at the end of the process than at the beginning.

43. The ratio of Coulomb's constant  $k$  to the magnetic constant  $k$  is equal, where  $c$  is the speed of light, to
- (A)  $c^2$
  - (B)  $c$
  - (C)  $\sqrt{c}$
  - (D)  $2c$
44. Comparing gravitational fields to electric fields shows that they are very similar. Which of the following is a major difference?
- (A) Gravitational fields do not have direction, whereas electric fields do.
  - (B) Gravitational fields do not have equipotential lines associated with them, whereas electric fields do.
  - (C) Gravitational field lines show the direction of force for positive mass, whereas electric field lines show the direction for negative charge.
  - (D) Gravitational field lines do not have sources, whereas electric field lines can be sourced by positive charges.
45. Bernoulli's equation for fluids is essentially
- (A) Newton's laws for fluids
  - (B) energy conservation for fluids
  - (C) momentum conservation for fluids
  - (D) Bernoulli's equation is not based on any of these
46. Which of the following transformations could a transformer accomplish? Select two answers.
- (A) Increasing input AC voltage
  - (B) Increasing input AC current
  - (C) Increasing input DC voltage
  - (D) Increasing input DC current
47. Which of the following are synonyms for voltage? Select two answers.
- (A) Electromotive force
  - (B) Electrical potential energy
  - (C) Potential difference
  - (D) amp · hr
48. Which of the following can produce polarized light? Select two answers.
- (A) A liquid crystal display (LCD)
  - (B) Reflection
  - (C) Refraction
  - (D) Fluorescent bulbs



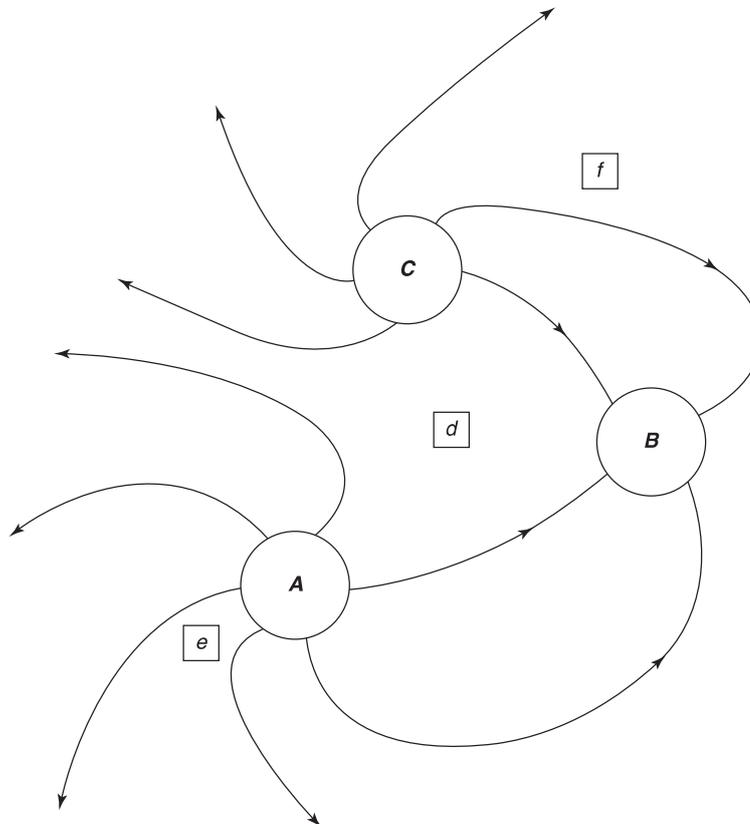
49. What energies could be associated with a photon emitted during an overall transition from level 4 to level 2 of the diagram above? Select two answers.
- (A) 1.9 eV
  - (B) 5.7 eV
  - (C) 2.5 eV
  - (D) 6.3 eV
50. The electric field near the surfaces of a rectangular solid conducting object with 15 microcoulombs of extra charge can be described as which of the following? Select two answers.
- (A) Directed normally outward near the outside surfaces
  - (B) Uniform in strength near all outside surfaces
  - (C) Zero on the inside
  - (D) Directed normally inward near the inside surfaces

**SECTION II: FREE-RESPONSE****Time: 90 minutes****4 questions**

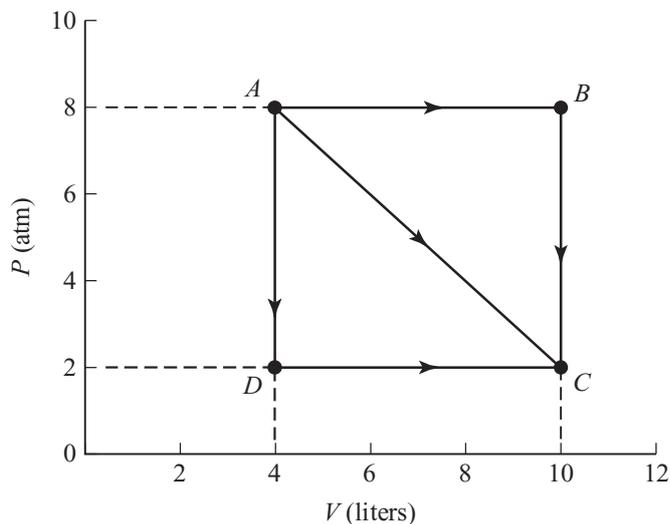
**DIRECTIONS:** You have 90 minutes to complete this portion of the test. You may use a calculator and the information sheets provided in the appendix.

- A laser of unknown wavelength is provided to students along with a screen with two closely spaced slits ( $1.67 \mu\text{m}$ ) cut in it. Students are also provided with metersticks.

  - Describe an experimental procedure to determine the wavelength of the laser. You may include a labeled diagram of your setup to help in your description. Indicate what measurements you would take and how you would take them. Include enough detail so that another student could carry out your procedure.
  - What are the common sources of error or expected deviations from ideal results that might happen during this investigation?
  - If the wavelength of the laser is  $632.8 \text{ nm}$  and the two-slit screen indicates spacing of  $1.67 \mu\text{m}$ , determine some reasonable expected measurement a student might make in the procedure outlined above. Estimate a margin of error for each measurement, and justify this margin of error.
- Use the electric field drawing below to answer the questions. *A*, *B*, and *C* are physical sources of charge. Points *e*, *d*, and *f* are points within the field.



- Describe the relative amount of charge and type (positive or negative) at each of locations  $A$ ,  $B$ , and  $C$ . Explain your answers.
  - Rank the relative strength of the net electric field at each of points  $e$ ,  $d$ , and  $f$ . Explain your answer.
  - By extending the existing sketch, sketch out what the field lines would look like from very far away from these charges. Assume no other charges are present.
  - On the sketch above, draw a single, complete equipotential surface that runs through point  $f$ .
  - How can there always be electric potential at point  $f$  and yet the electrical potential energy sometimes be zero?
  - If a proton was placed at point  $f$ , in what direction (if any) would it experience a force? Would its change in electrical potential energy be negative or positive as it moved in response to this electrical force? Explain your reasoning.
  - Repeat the answers to the questions in part (f) but for an electron placed at point  $e$ .
3. An ideal gas expands from points  $A$  to  $C$  along three possible paths.



- Is it expected that final temperature at point  $C$  be path dependent? Justify your answer qualitatively with no calculations.
- Discuss and compare the flow of thermal energy along the three paths ( $AC$ ,  $ABC$ ,  $ADC$ ). Indicate the direction of heat for each pathway (into or out of the gas) and the relative amount of thermal energy involved. Justify your answer qualitatively with no calculations.
- Calculate the work done along path:
  - $ABC$
  - $AC$
  - $ADC$
- Is there a way to go from  $A$  to  $C$  with no thermal energy exchanged with the environment? If so, describe and sketch the path on a  $P$ - $V$  diagram.
- Is there a way to go from  $A$  to  $C$  with no temperature change? If so, describe and sketch the path on a  $P$ - $V$  diagram.

4. Given the following information:

Proton mass = 1.0078 u

Neutron mass = 1.0087 u

Mass of  ${}^{226}_{88}\text{Ra}$  = 226.0244 u

- (a) Determine the mass defect for this isotope of radium.
- (b) What does this mass defect represent? Explain both qualitatively and quantitatively.
- (c) If radium-88 naturally undergoes alpha decay, write down a nuclear reaction for this process. Be sure to show any energy required ( $Q$ ) or released by this process. If a new element is formed and you are unsure of its symbol, you may use an X to represent that new element. Use the same isotope notation as that given in the information above.
- (d) In the reaction in part (c), compare the total mass defects on the reactant side to the mass defect found in part (a):
- \_\_\_\_\_ The reactants have the same mass defect.
- \_\_\_\_\_ The reactants have a larger mass defect.
- \_\_\_\_\_ The reactants have a smaller mass defect.
- Justify your choice qualitatively, without using equations.