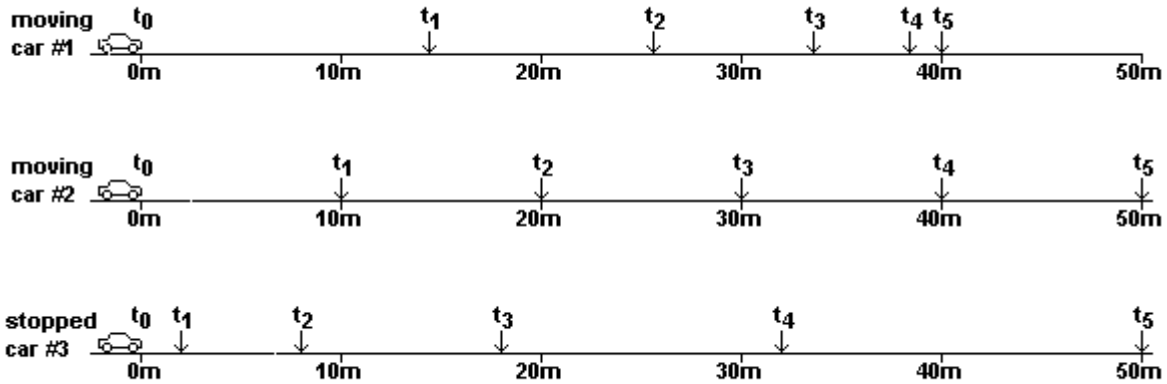**Questions 1 through 4 refer to the following scenario:**
At t_0, two cars moving along a highway are side-by-side as they pass a third car stopped on the side of the road. At this moment the driver of the first car steps on the brakes while the driver of the stopped car begins to accelerate. The diagram below show the positions of each car for the next 5 seconds.

1. During which time interval would cars #2 and #3 be moving at the same average speed?
    A) t_0 to t_1 **B)** t_1 to t_2 **C)** t_2 to t_3 **D)** t_3 to t_4 **E)** t_4 to t_5

2. About what position after t_o would car #1 and car #2 have been side by side?
    A) 0 m   **B)** 15 m   **C)** 26 m   **D)** 37 m   **E)** 39 m

3. Which of the three cars had the greatest average speed during these 5 seconds?
    A) car #1   **D)** car #2 and car #3 had the same average speed
    B) car #2   **E)** all three cars had the same average speed
    C) car #3

4. If car #3 continues to constantly accelerate at the same rate what will be its position at the end of 6 seconds?
    A) 22 m   **B)** 68 m   **C)** 72 m   **D)** 78 m   **E)** 94 m

5. Which of the following resistances could <u>NOT</u> be produced by a circuit containing only three identical 6 ohm resistors?
    A) 18 Ù   **B)** 14 Ù   **C)** 9 Ù   **D)** 4 Ù   **E)** 20 Ù

6. After striking the lens shown in the diagram at right, the light ray will most likely follow which path?
    A) path A
    B) path B
    C) path C
    D) path D
    E) path E
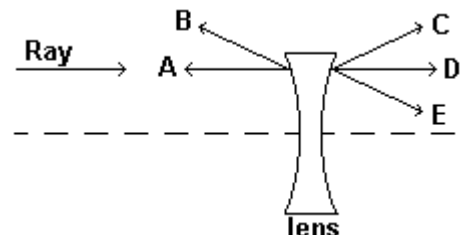
7. A force of 6 newtons and a force of 10 newtons can be combine to form a resultant with a magnitude of which of the following

   **A)** 0 newtons   **B)** 2 newtons   **C)** 8 newtons   **D)** 20 newtons   **E)** 60 newtons

8. A 50 kilogram gymnast falls freely from a height of 4 meters on to a trampoline. The trampoline then bounces her back upward with a speed equal to the speed at which she first struck the trampoline. What is the average force the trampoline applies on the gymnast?

    A)   50 newtons   **D)** 2000 newtons

    B) 200 newtons   **E)** More information is required

    C) 500 newtons

9. The 1st Law of Thermodynamics is a simple statement of the Law of the Conservation of Energy. It was first announced about the time of

    A) the First World War

    B) the U.S. Civil War

    C) the French Revolution

    D) Christopher Columbus' discovery of the New World

    E) the fall of the Roman Empire

10. Each member of a family of six owns a computer rated at 500 watts in a 120 V circuit. If all computers are plugged into a single circuit protected by a 20 ampere fuse, what is the maximum number of the computers can be operating at the same time?

    A) 1   **B)** 2   **C)** 3   **D)** 4   **E)** 5 or more

Questions 11 and 12 refer to the following scenario:

A 5 kg block rests on a flat plane inclined at an angle of 30° to the horizon as shown in the diagram below.
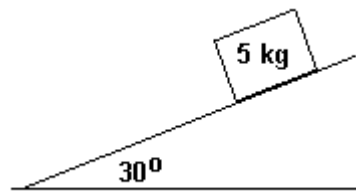
11. What would be the acceleration of the block down the plane assuming the force of friction is negligible?

    A) 0.5 m/s^2 **B)** 0.87 m/s^2 **C)** 5 m/s^2 **D)** 8.7 m/s^2 **E)** 10 m/s^2

12. If the block is placed on a second plane (where friction is significant) inclined at the same angle, it will begin to accelerate at 2.0 m/s. What is the force of friction between the block and the second inclined plane?

    A) 10 N   **B)** 15 N   **C)** 25 N   **D)** 43.3 N   **E)** 50 N

13. According to the Bohr theory of the hydrogen atom, electrons starting in the 4th energy level and eventually ending in the ground state could produce a total of how many lines in the hydrogen spectra?

    A) 7   **B)** 6   **C)** 5   **D)** 4   **E)** 3

14. A football is kicked a distance of 50 yards down field. Neglecting air resistance, which of the following statements would be <u>INCORRECT</u> when the football reaches its highest point.

    A) all of the ball's original kinetic energy has been changed into potential energy
    B) the ball's horizontal velocity is the same as when it left the kicker's foot
    C) the ball will have been in the air one-half its total flight time
    D) the ball has an acceleration of g
    E) the vertical component of the velocity is equal to 0

15. A rectangular piece of metal 3 cm high by 6 cm wide has a hole cut in its center 1cm high by 4 cm wide as shown in the diagram at right. As the metal is warmed from 0°C to 100°C, what will happen to the dimensions of the hole?

    A) both height and width will increase
    B) both height and width will decrease
    C) both height and width will remain unchanged
    D) height will decrease while width will increase
    E) height will increase while width will decrease
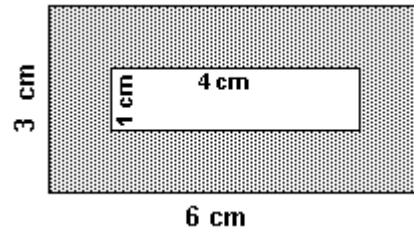
16. The mass of a planet can be calculated if it is orbited by a small satellite by setting the gravitational force on the satellite equal to the centripetal force on the satellite. Which of the following would <u>NOT</u> be required in this calculation?

    A) the mass of the satellite
    B) the radius of the satellite's orbit
    C) the period of the satellite's orbit
    D) Newton's universal gravitational constant
    E) all of the above are required for this calculation

17. If 25% of a sample of a radioactive isotope decays in 4 hours, we would estimate the sample's half life to be about

    A) 1.9 hours   **B)** 4.0 hours   **C)** 8.0 hours   **D)** 9.6 hours   **E)** 13.8 hours

18. Which of the following is the best statement of Pascal's Law?

    A) pressure on a confined fluid is transmitted equally in all directions
    B) a numerical arrangement where each number is the sum of the two numbers above
    C) two electrons cannot occupy the same quantum state at the same time
    D) the volume of a gas is directly related to its temperature
    E) the farther away a galaxy the faster it is receding

19. Three identical capacitors each with a capacitance of C are connected as shown in the following diagram. What would be the total equivalent capacitance of the circuit?

A) $0.33\ C$
B) $0.67\ C$
C) $1.0\ C$
D) $1.5\ C$
E) $3.0\ C$
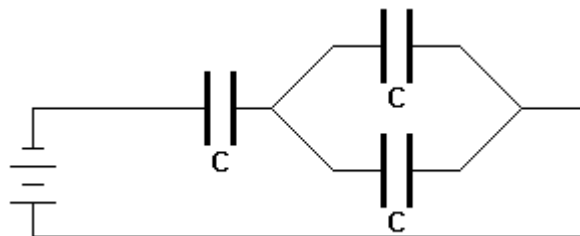
20. When submerged under water, the apparent mass of one cubic centimeter of pure gold is 18.3 grams. What would be its mass in air?

A) 16.3 grams   B) 17.3 grams   C) 18.3 grams   D) 19.3 grams   E) 20.3 grams

Questions 21 and 22 refer to the following scenario:
Five identical light bulbs each, with a resistance of 10 ohms, are connected in a simple electrical circuit with a switch and a 10 volt battery as shown in the diagram below.
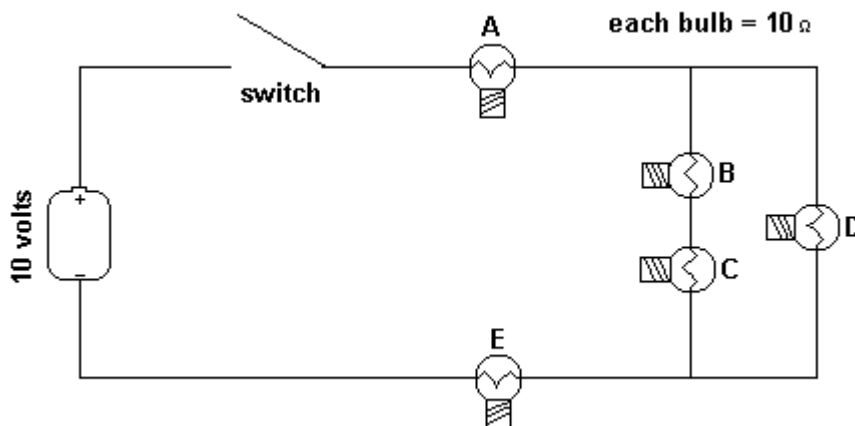
21. The steady current in the above circuit would be closest to which of the following values?

A) 0.2 amp   B) 0.37 amp   C) 0.5 amp   D) 2.0 amp   E) 5.0 amp

22. Which bulb (or bulbs) could burn out without causing other bulbs in the circuit to also go out?

A) only bulb D   D) only bulbs C or D
B) only bulb E   E) bulbs B, C, or D
C) only bulbs A or E

23. A object is placed 10 cm in front of the center of a concave curved mirror with a radius of curvature of 10 cm. About how far from the mirror will the real image of the object be formed?

A) 0 cm   D) 20 cm
B) 5 cm   E) No image is formed
C) 10 cm

24. An electric heater draws 13 amperes of current when connected to 120 volts. If the price of electricity is $0.10/kWh, what would be the approximate cost of running the heater for 8 hours?
     A) $0.19   **B)** $0.29   **C)** $0.75   **D)** $1.25   **E)** $1.55

Questions 25 and 26 refer to the following scenario:
The diagram below represents 5 different standing sound waves set up inside of a set of organ pipes 1 meter long.

CLOSED PIPES   OPEN PIPES

1 meter
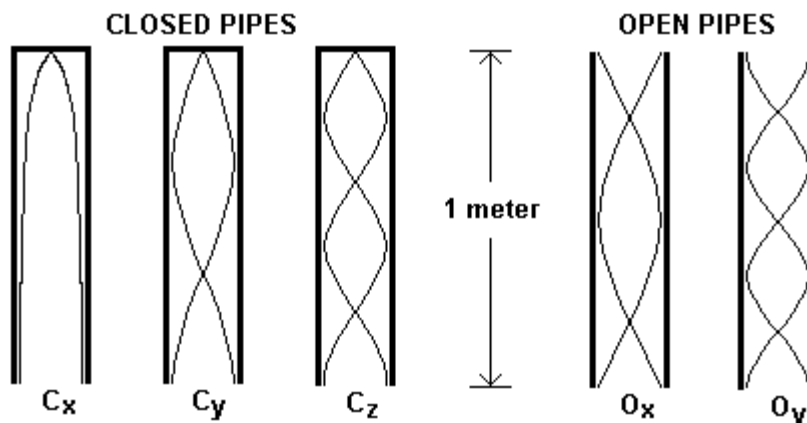
C_x C_y C_z O_x O_y

25. What is the length of the longest wavelength shown?
     A) .5 m   **B)** .75 m   **C)** 1 m   **D)** 2 m   **E)** 4 m

26. Which organ pipe shows a standing wave which has twice the frequency of one of the other waves shown?
     A) C_y **D)** O_y
     B) C_z **E)** C_y, C_z, O_x & O_y
     C) O_x

27. A spinning ice skater can increase his rate of rotation by bringing his arms and free leg closer to his body. How does this procedure affect the skater's rotational momentum and kinetic energy?
     A) rotational momentum remains the same while kinetic energy increases
     B) rotational momentum remains the same while kinetic energy decreases
     C) both rotational momentum and kinetic energy remain the same
     D) rotational momentum increases while kinetic energy remains the same
     E) both rotational momentum and kinetic energy increase

28. Light travels from material X with an index of refraction of n = 1.5 to material Y with an index of refraction of n = 2.0. If the speed of light in material Y is v, what is the speed of light in material X?
     A) 0.56 v **B)** 0.75 v **C)** 1.33 v **D)** 1.78 v **E)** 3.0 v

29. A 200 gram sample of copper is submerged in 100 grams of water until both the copper and water are at the same temperature. Which of the following statements would be true.
   A) the molecules of the water and copper would have equal average speeds
   B) the molecules of the water and copper would have equal average momenta
   C) the molecules of the water and copper would have equal average kinetic energies
   D) the water molecules would have twice the average momentum of the copper molecules
   E) the copper molecules would have twice the average speed of the water molecules

30. Lenz's law concerning the direction of an induced current in a conductor by a magnetic field could be a restatement of
   A) Ampere's law   **D)** the Law of Conservation of Energy
   B) Ohm's law   **E)** none of these
   **C)** Maxwell's Law

31. A positive point charge of $+q$ and a negative point charge of $-q$ are separated by a distance d. What would be the magnitude of the electric field midway between the two charges?

   A) $E = 0$ **B)** $E = \dfrac{kq}{d^2}$ **C)** $E = \dfrac{2kq}{d^2}$ **D)** $E = \dfrac{4kq}{d}$ **E)** $E = \dfrac{8kq}{d^2}$

32. One stereo loudspeaker produces sound with a wavelength of 0.68 meters while the other speaker produces sound with a wavelength of 0.65 meters. What would be the resulting beat frequency?
   A) 3 Hz   **B)** 23 Hz   **C)** 66.5 Hz   **D)** 500 Hz   **E)** 11,333 Hz

33. A small ball rolls down a ramp, across a horizontal table top and off the table edge. Which of the following would best represent a graph of the magnitude of the ball's acceleration vs time?

   A)   B)   C)   D)   E)
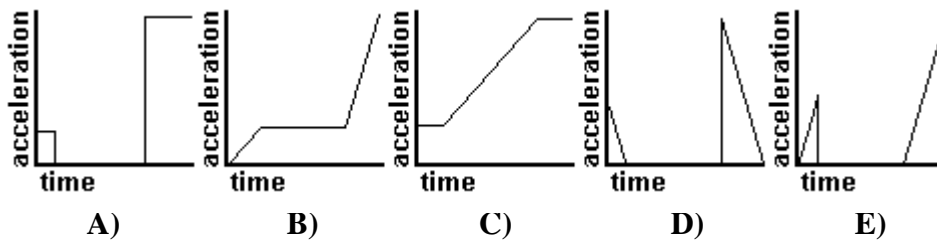
34. Two toy cars with different masses originally at rest are pushed apart by a spring. Which of the following statements would <u>NOT</u> be true?
   A) both toy cars will acquire equal but opposite momenta
   B) both toy cars will acquire equal kinetic energies
   C) the more massive toy car will acquire the least speed
   D) the smaller toy car will experience an acceleration of greatest magnitude
   **E)** All of the above statements are true

35. The intensity of sound 10 meters from a tornado siren is a very loud 130 decibels. At what distance would you need to be for the intensity to drop to 90 decibels?
    A) 14.3 m   **B)** 31.8 m   **C)** 210 m   **D)** 400 m   **E)** 1000 m

36. A mass *m* is attached to a spring with a spring constant k. If the mass is set into simple harmonic motion by a displacement d from its equilibrium position, what would be the speed, *v*, of the mass when it returns to equilibrium position?

    A) $v = \sqrt{\dfrac{kd}{m}}$ **B)** $v^2 = \dfrac{kd}{m}$ **C)** $v = \dfrac{kd}{mg}$ **D)** $v^2 = \dfrac{mgd}{k}$ **E)** $v = d\sqrt{\dfrac{k}{m}}$

37. A long straight wire viewed end on carries a conventional electric current out of the paper as shown in the diagram. What is the direction of the associated electric field at point P?

Long wire viewed end on
Current out of paper
pt.P
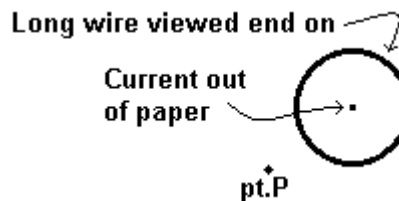
A)   B)   C)   D)   E) There would be no electric field produced by the current at pt. P

38. The S-waves (transverse) and P-waves (longitudinal) produced by earthquakes travel at different speeds through the earth. If the S-waves travel about 4000 m/s while the P-waves travel at nearly 7000 m/s, how far away must an earthquake be for the P-waves to arrive 2 minutes before the S-waves?
    A) 360 km   **B)** 480 km   **C)** 840 km   **D)** 1120 km   **E)** 1320 km

39. Suppose the engine and propeller of a single engine plane are turning in a clock wise direction with respect to the pilot. The gyroscopic action of the moving parts will cause the plane to move in which direction as the pilot tries to make a sharp left hand turn.
    A) spin clockwise around the long axis of the plane
    B) spin counter-clockwise around the long axis of the plane
    C) nose up
    D) nose down
    E) none of the above

40. A student tunes a crystal radio set by means of a simple RLC circuit to receive a radio station broadcasting at 660 kHz. To receive a station broadcasting at 1320 kHz the capacitor in the RLC circuit could be changed. By what factor must the original capacitance be multiplied to tune in the RLC circuit to the new frequency?
    A) 0.25   **B)** 0.50   **C)** 2   **D)** 4   **E)** 16

PHYSICSBOWL 2001

ANSWERS

Question	Answer	Question	Answer
1	C	21	B
2	D	22	A
3	D	23	C
4	C	24	D
5	B	25	E
6	C	26	D
7	C	27	A
8	E	28	C
9	B	29	C
10	D	30	D
11	C	31	E
12	B	32	B
13	B	33	A
14	A	34	B
15	A	35	E
16	A	36	E
17	D	37	E
18	A	38	D
19	B	39	C
20	D	40	A