O.A.P.T. Physics Contest

May 2, 2000 Time: 1.0 hour

The Ontario Association of Physics teachers is affiliated with The American Association of Physics Teachers

ACKNOWLEDGMENTS The assistance of the following in the preparation of this contest is gratefully acknowledged.

Contest Committee:	Terry Price (convenor), Doug Abe (question paper), Kevin Soltes, Pauline Plooard, Peter Spencer, Daniel Muttiah, Neil Dyal, Edouard Tcherner
Contest Reviewers:	John Breukelaar (Trent U.), Dr. John Pitre (U. of Toronto)
Assistance from:	Dr. Ernie McFarland (U. of Guelph)
Submitted questions from:	Contest Committee, Don Bell, Gabriela Smeianu

In addition, Physics Departments at the following universities have shown interest in your physics education and have generously contributed funds for prizes given to the provincial winners.

Lakehead University	University of Guelph	University of Waterloo
Laurentian University	University of Ottawa	University of Western Ontario
McMaster University, Engineering	University of Toronto	University of Windsor
Queen's University	U. of Toronto, St. George	Wilfrid Laurier University

The following companies have graciously contributed to the prize awards also.

CCS Educational Northwest Scientific Texas Instruments Vernier Software

PRIZES The two students having the highest score in each school will be recognized by the OAPT with certificates. The top students in the province will receive a cash prize and/or a calculator with a special certificate from OAPT.

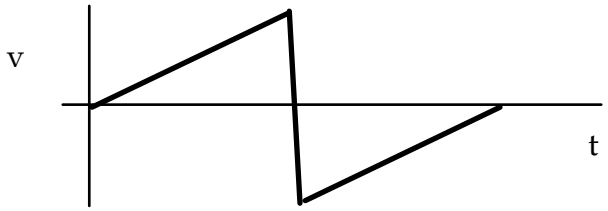
INSTRUCTIONS

1. *For each question select the <u>best</u> answer from the choices offered.*
2. *When you have finished, carefully transfer your answers to the computer answer sheet as instructed by your teacher.*

3. *Solutions are not required.*
4. *Calculators may be used, but no other aids are allowed.*
5. *All questions are of equal value and there are no marks deducted for incorrect answers*

DATA acceleration due to gravity = 9.8 m/s^2

1. Which of the following descriptions matches the motion shown on the velocity-time graph below?



A) A ball falling down and bouncing back up.
B) A rock thrown up and falling down.
C) A car climbing a hill and falling off a cliff.
D) A mass oscillating on the end of a spring.
E) A person walking at steady speed, turning around, and walking back.

2. A car has an initial velocity of 15 m/s. For how many seconds must it accelerate at a constant rate of 3.0 m/s^2 before its average velocity is equal to twice its initial velocity?
A) 5.0 s B) 10 s C) 15 s
D) 20 s E) 25 s

3. A rock was filmed as it fell from rest. Analysis showed an acceleration of 9.8 m/s^2 [down]. Suppose the film were run backwards, at the same frame rate. What would the apparent acceleration of the rock be now?
A) 9.8 m/s^2 [down] B) 9.8 m/s^2 [up] C) 0 m/s^2
D) none of these E) indeterminate

4. Bob exercises his dog on his daily 30 minute walk by throwing a stick that his dog faithfully chases and retrieves. In which direction should Bob throw the stick to keep the dog running for the longest time?
Assume constant speeds for Bob and the dog (negligible acceleration times) and that his throws are instantaneous and consistent.
A) Must be in front of him
B) Must be in back of him
C) Must be 45° to Bob's direction of motion
D) Must be 90° to Bob's direction of motion
E) In any direction, as all are equivalent

5. Two trains are 1.0 km long. Train X moves at 45 km/h [E] while Train Y moves at 30 km/h [W] on a parallel track. How much time elapses from the moment the two locomotives meet, until the two cabooses are just separating?
A) 240 s B) 160 s C) 120 s
D) 96 s E) 80 s

6. An elephant, a feather and a dart are dropped from rest in a high tree. Which encounters the greatest force of air resistance, while falling to the ground?
   A) elephant
   B) feather
   C) dart
   D) they all encounter the same force of air resistance
   E) cannot tell since no information about terminal velocity is given

7. A bottle dropped from a balcony strikes the sidewalk below with a particular speed. In order for the bottle to strike with double that speed, the bottle must be dropped from a height that is
   A) 1.4 times higher
   B) twice as high
   C) three times as high
   D) four times as high
   E) eight times as high

8. A pulley has a light rope running over it, with a 10 N weight on one side and a 20 N weight on the other. Ropes always pull with equal force on each end; this is called tension. If the masses are allowed to fall, what is the tension, T, in the rope?
   A) 0 N B) 0 N < T < 10 N C) 10 N
   D) 10 N < T < 20 N E) 20 N

9. A car starts from rest atop a perfectly smooth hill. At the bottom of the hill, its speed reaches 4.0 m/s. The same car starts again from the top of the hill, but with an initial speed of 3.0 m/s. What will be its speed at the bottom of the hill, in the second case?
   A) 3.0 m/s B) 4.0 m/s C) 5.0 m/s
   D) 6.0 m/s E) 7.0 m/s

10. Tina is performing a standard acceleration due to gravity experiment, but she is performing the experiment in an old salt mine, 1.0 km below sea level. Tina will measure g to be
   A) 0 m/s^2 B) < 9.8 m/s^2 C) 9.8 m/s^2
   D) > 9.8 m/s^2 E) more information needed

11. Electrical resistor A has half the resistance of resistor B. Under what conditions will the electrical power dissipated in A be greater than the power dissipated in B?
   A) When they are connected in series.
   B) When they are connected in parallel.
   C) In both series or parallel connections.
   D) A never dissipates more energy than B.
   E) A will always dissipate more energy than B.

12. A long uniform wire has a resistance R. If this wire is cut into N identical pieces, what would be the total resistance when the N pieces are wired in parallel?
   A) N^2R B) NR C) R
   D) R/N E) R/N^2

13. A neutral plastic comb feels no force from a large horseshoe magnet, when it is brought close. Suppose the comb were charged electrostatically. Under what conditions will it feel an electromagnetic force due to the magnet?
   A) The comb will <u>never</u> feel an electromagnetic force from the magnet.
   B) If the comb is charged <u>negatively</u> overall, it will repel from the magnet.
   C) If the comb is charged <u>positively</u> overall, it will repel from the magnet.
   D) If the comb is <u>moving</u> through the jaws of the magnet, it will feel a force from the magnet.
   E) If the comb has one end charged <u>positive</u> and one end <u>negative</u>, it will feel a force from the magnet.

14. How much energy is consumed by a 100 W light bulb turned on for 5.0 minutes?
   A) 20 J B) 500 J C) 3 000 J
   D) 15 000 J E) 30 000 J

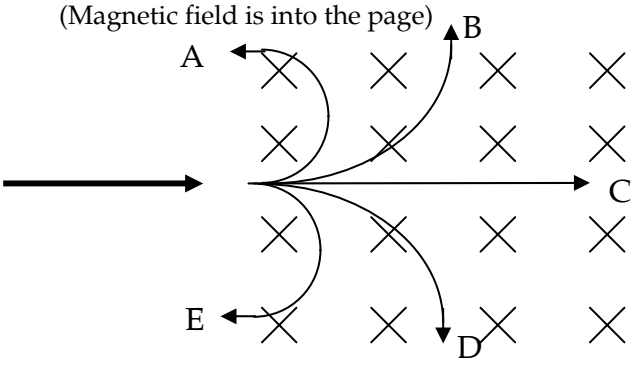
15. Two resistors in series have a resistance of 10 Ω and in parallel have a resistance of 1.6 Ω. What is the value of the two resistances?
   A) 1 Ω, 9 Ω B) 2 Ω, 8 Ω C) 3 Ω, 7 Ω
   D) 4 Ω, 6 Ω E) 5 Ω, 5 Ω

16. Two parallel wires are carrying electrical current flowing in the same direction. These wires will tend
   A) to repel each other.
   B) to attract each other.
   C) to exert no force on each other.
   D) to twist at right angles to each other.

E) to spin along their long axis.

17. In the secondary circuit of an ideal transformer, compared to the primary circuit, we can find an increase in
A) energy B) power C) current
D) all of these E) none of these

18. When the velocity of charged particles entering a uniform magnetic field is perpendicular to the direction of the field, the particles travel in circles whose radius varies inversely with the particle's charge and directly as the mass. The diagram below shows the tracks of 6 particles as they were shot at the same velocity into a magnetic field. The particles were an electron, a proton, a neutron, and their respective antiparticles. Which track did the antiproton make?
(Magnetic field is into the page)



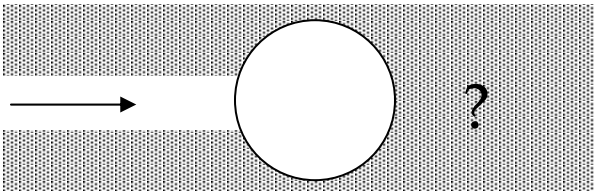
A) A B) B C) C D) D E) E

19. A sailboat has an aluminum mast. It is moving with high velocity near the equator. Due to induction with the Earth's magnetic field, the top of the mast becomes negative, relative to the foot of the mast. For maximum voltage, what direction should the sailboat move?
A) West B) East C) South
D) North E) All are equivalent.

20. A battery is connected to the primary coil of a transformer, through a switch. The secondary coil is connected to a small light bulb. Choose the correct statement,
A) The lamp will light when the switch is closed, and remain lit while the switch is closed.
B) The lamp will never light when the switch is closed or opened with this arrangement.
C) The lamp will light momentarily only when the switch is closed.
D) The lamp will light momentarily only when the switch is opened.
E) The lamp will light momentarily when the switch is closed and again when it is opened.

21. In viewing the primary rainbow, the sun is usually at one's back as it strikes water droplets in front of you. In order to produce the rainbow, sunlight need only
A) reflect B) refract C) diffract
D) A and B E) A, B, and C

22. A parallel beam of light is travelling underwater, when it encounters a large spherical bubble of air. After the beam leaves the bubble, it will



A) diverge
B) converge
C) remain parallel, with the same width
D) remain parallel but be wider
E) remain parallel but be narrower

23. Two converging lenses have the same focal length, but lens X has a diameter of 10 cm, while lens Y has a diameter of 5 cm. Both lenses are used separately to form an image of a far away tree. Compare the two images produced.
A) Lens X produces a larger image of the tree than lens Y, and brighter.
B) Lens X produces a larger image of the tree than lens Y, but of the same brightness.
C) Lens X produces the same size image of the tree as lens Y, but brighter.
D) Lens X produces the same size image of the tree as lens Y, and of the same brightness.
E) Lens X produces a smaller image of the tree than lens Y, but much brighter.

24. A converging lens is used to form an image of a candle placed in front of it. The resulting image is inverted and the same size. The lens is then replaced with one identical to it in physical dimension, but of higher index of refraction. After refocussing, the new image is
A) the same size
B) larger in size
C) smaller in size
D) larger or smaller depending on how much the index changed.
E) non-existent, depending on how much the index changed.

25. A long pendulum is pulled aside so its string is 5° to the vertical. When the bob is released from rest, it takes 0.10 s to return to vertical. If the bob is now pulled out to 10°, and released from rest, the time that it will take to return to vertical is closest to
A) 0.050 s B) 0.10 s C) 0.14 s
D) 0.15 s E) 0.20 s

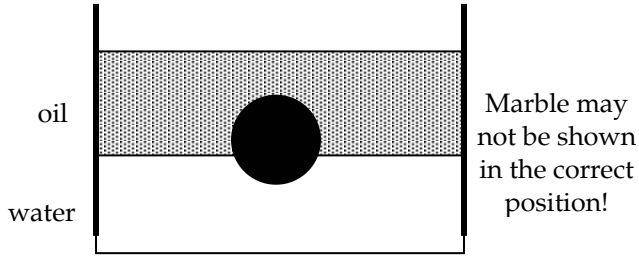
26. An open-ended air column of length 35 cm resonates with a speaker sounding a 500 Hz note. If the air is vibrating in the fundamental mode, what temperature is the air?
(Recall: speed of sound = 332 + 0.60T m/s, where T is temperature in Celsius degrees)
A) –262° C B) 0° C C) 18° C
D) 30° C E) 637° C

27. Which wave of the following wavelengths could NOT make a standing wave in a 1.0 m string, with nodes at both ends?
A) 2.0 m B) 1.0 m C) 0.75 m
D) 0.50 m E) 0.25 m

28. In the elusive quest for Dark Matter, attention has swung towards searching for the WIMP. What does this acronym stand for?
A) Weakly Interacting Massive Particle
B) Wonderfully Implausible Missing Proton
C) White Interstitial Meson Particle
D) Work-Impulse Momentum Pion
E) Weiberg-Isaac Matter Photon

29. The 1999 Nobel Prize in Physics was awarded jointly to Gerardus 't Hooft and Martinus J.G. Veltman, for their work in renormalizing non-abelian gauge theories. Which area of Physics is this most closely associated with?
A) Cosmology
B) Optoelectronics
C) High-Temperature Superconductivity
D) General Relativity
E) High-Energy Physics

30. A uniform marble of density 0.50 g/cm^3 is floating in pure water, density 1.0 g/mL. Oil, of density 0.20 g/mL is poured over both the marble and the water, forming a new layer. What percentage of the marble's volume is in the water?



A) 30% B) 38% C) 44%
D) 50% E) 75%