UNIVERSITY OF SASKATCHEWAN

Department of Physics and Engineering Physics

High School Physics Scholarship Competition

May 9, 2001 Time: 90 minutes

This competition is based on the Saskatchewan High School Physics Core Curriculum for Physics 20 and Physics 30.

INSTRUCTIONS:

1. You should have a test paper and an OMR (Optical Machine Readable) or Computer scan sheet. The test paper consists of 8 pages. **The student should check that the test paper is complete**.
2. Enter your **name** and **school** on the OMR sheet.
3. Enter your personal information on the table below.
4. At the end of the examination **both** this cover page **and** the OMR sheet must be submitted.
5. All questions are of equal value.
6. No marks will be deducted for wrong answers.
7. Calculators **may not** be used. (None of the questions require the use of a calculator.)

PLEASE **PRINT** THE FOLLOWING INFORMATION

Name: _____

School: _____

Physics Teacher: _____

Home Address: _____

_____

_____

Postal Code: _____

Telephone: _____

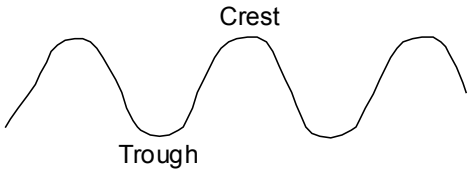
continued on page 2 ...

FOR EACH OF THE FOLLOWING QUESTIONS ENTER THE MOST APPROPRIATE RESPONSE ON THE OMR SHEET.

1. You are listening to sound of a certain frequency. Which one of the following statements about the sound wave which is travelling through the air is correct if the frequency of the sound is increased?

(A) The wavelength of the sound wave increases.
(B) The wavelength of the sound wave remains the same.
(C) The wavelength of the sound wave decreases.
(D) The speed of the sound wave increases.
(E) The speed of the sound wave decreases.

2. The horizontal distance between a wave crest and a wave trough on the surface of water is

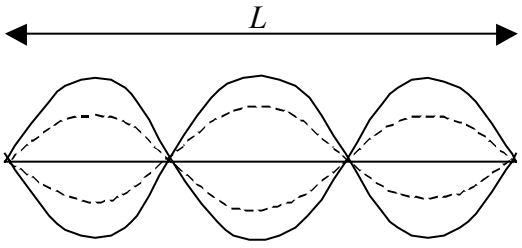


(A) one quarter of the wave's wavelength.
(B) one half of the wave's wavelength.
(C) equal to the wave's wavelength.
(D) two times the wave's wavelength.
(E) four times the wave's wavelength.

3. When two water waves overlap each other the resulting disturbance is governed by the "Principle of Superposition". If, at a particular place and time, a wave crest from one wave overlaps with a wave trough from another wave, we find that the resulting disturbance at that place and time is

(A) large because destructive interference has occurred.
(B) small because destructive interference has occurred.
(C) large because constructive interference has occurred.
(D) small because constructive interference has occurred.
(E) cannot be determined without knowing more information.

4. A guitar string has a length L and is fixed at both ends. It is made to vibrate with the standing wave pattern shown in the diagram. The wavelength of the wave travelling up and down the string is



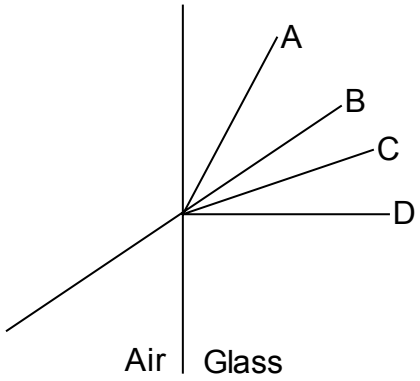
(A) L
(B) $\frac{3}{2}L$
(C) $\frac{2}{3}L$
(D) $\frac{1}{3}L$
(E) $\frac{1}{2}L$

5. Light travels fastest

(A) in a vacuum.
(B) in water.
(C) in glass.
(D) in diamond.
(E) It travels at the same speed in all of these media.

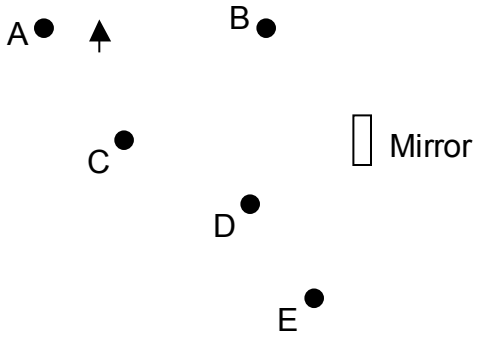
continued on page 3 ...

6. Shown here are some possible paths of a light ray going from glass into air or from air into glass. In the diagram, you are not told whether the light is going from left to right or from right to left. Which path did the light follow?



(A) Path A
(B) Path B
(C) Path C
(D) Path D
(E) One cannot answer this without knowing in which direction the light is going.

7. At which one of the points, labelled A, B, C, D or E, would you need to have your eye if you want to see an image of the arrow in the mirror?



8. An object is situated between the surface of a converging mirror (concave mirror) and its focal point. The image formed in this case is

(A) real and inverted.
(B) real and upright.
(C) virtual and inverted.
(D) virtual and upright.
(E) No image is formed.

9. The critical angle for a water-air interface is 48.8°. This means that light travelling from within water and striking a water-air interface with an incident angle greater than 48.8° will be

(A) absorbed.
(B) partially refelected and partially transmitted with an angle of refraction greater that 48.8°.
(C) partially refelected and partially transmitted with an angle of refraction less that 48.8°.
(D) totally transmitted with an angle of refraction greater that 48.8°.
(E) totally reflected.

continued on page 4 ...

10. It is a well known fact that water has a higher specific heat capacity than iron. Now, consider equal masses of water and iron that are initially at the same temperature. The same amount of heat is added to each. Which one of the following statements is true?

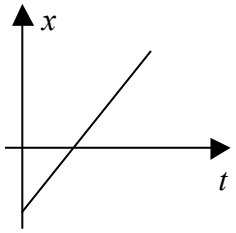
(A) They remain at the same temperature.
(B) The iron is now warmer than the water.
(C) The water is now warmer than the iron.
(D) We cannot tell which is warmer without knowing if the heat capacity of water is greater than two times the heat capacity of iron.
(E) We cannot tell which is warmer without knowing the exact heat capacities of water and iron and the exact masses of water and iron.

11. Which one of the following is **NOT** a vector quantity?

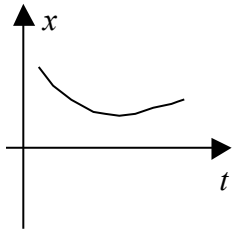
(A) Force.
(B) Acceleration.
(C) Velocity.
(D) Displacement.
(E) Work.

12. Which position verses time graph best represents a negative acceleration?

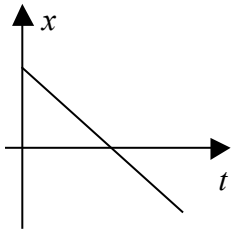
(A)



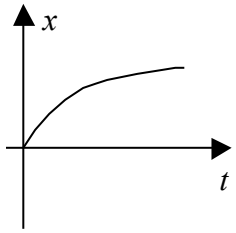
(B)



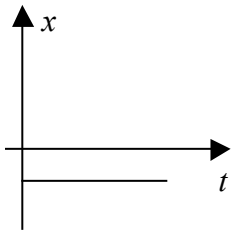
(C)



(D)



(E)



continued on page 5 ...

13. A car travelles a distance A due East. It then travels a distance A due North. The resultant displacement of the car is

(A) A distance $\sqrt{2}A$ in a direction 45° North of East.
(B) A distance $2A$ in a direction 45° North of East.
(C) A distance A^2 in a direction 45° North of East.
(D) A distance $\sqrt{2}A$ in a direction 45° South of East.
(E) A distance $2A$ in a direction due East.

14. A car travels a distance of 50 km in the +x direction in half an hour. In the next half hour it travels a distance of 30 km in the –x direction. What was the magnitude of the car's average velocity during this hour?

(A) 80 km/h
(B) 30 km/h
(C) 160 km/h
(D) 20 km/h
(E) 10 km/h

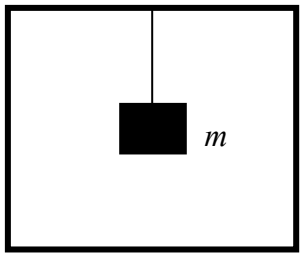
15. A car starts from rest and accelerates with a uniform acceleration. After 5 seconds its speed is v. What will be its speed at a time of 10 seconds after it started?

(A) v
(B) $\sqrt{2}v$
(C) $2v$
(D) $4v$
(E) $10v$

16. A net force **F** acts on a mass m and an acceleration **a** results. What acceleration results if a net force 4**F** acts on a mass $2m$? The acceleration is

(A) 8**a**
(B) 4**a**
(C) 2**a**
(D) **a**
(E) ½ **a**

17. A mass m is suspended by a string of negligible weight from the roof of an elevator. The elevator is accelerating upwards with acceleration of magnitude a. The acceleration due to gravity is g. What is the tension in the string?



(A) mg
(B) $g + a$
(C) $m(g + a)$
(D) $m(g – a)$
(E) ma

continued on page 6 ...

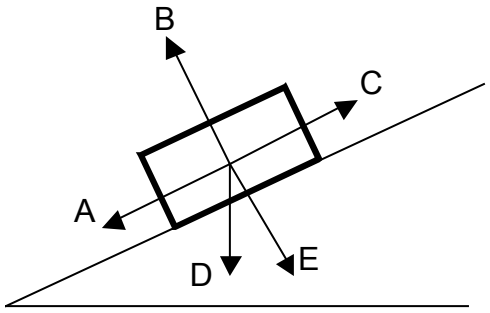
18. A large truck collides head on with a small car. The mass of the truck is ten times that of the car. During the collision the magnitude of the average force of the car on the truck is *F*. Therefore, during the collision, the magnitude of the average force of the truck on the car is

(A) *F*/10
(B) *F*
(C) 10*F*
(D) Much larger than 10*F*.
(E) Much smaller than *F*/10.

19. A rope is tied between two posts leaving as little slack as possible. A bird, with weight one Newton lands on the horizontal rope at its mid point, deflecting the rope downward very little. Which statement best describes the force the rope now exerts on each post?

(A) It increases by more than one Newton.
(B) It increases by exactly one Newton.
(C) It increases by exactly one-half Newton.
(D) It increases very slightly.
(E) It remains the same.

20. A box is placed on a frictionless inclined plane and it starts to slide down the slope. Which of the arrows on the diagram represent forces that would have to be included in a Free Body Diagram of the forces on the box as it is sliding down the slope?



(A) Arrows A, D and E only.
(B) Arrows A, B and D only.
(C) Arrows B, C and D only.
(D) Arrows B and D only.
(E) Arrows B and E only.

21. Object A has mass *m* and is moving with speed *v* and object B has mass 2*m* and is moving at speed ½ *v*. How do the kinetic energies of the two objects compare?

(A) Object A has twice the kinetic energy as object B.
(B) Object A has four times the kinetic energy as object B.
(C) Both objects have the same kinetic energy.
(D) Object B has twice the kinetic energy as object A.
(E) Object B has four times the kinetic energy as object A.

22. A 4 kg box moving with speed 2 m/s and a 1 kg box moving with speed 4 m/s are sliding along a horizontal frictionless surface. They both encounter the same constant force, which directly opposes their motion, and are brought to rest by it. Which statement best describes their respective stopping distances?

(A) The 4 kg box travels twice as far as the 1 kg box before stopping.
(B) The 4 kg box travels four times as far as the 1 kg box before stopping.
(C) The 1 kg box travels twice as far as the 4 kg box before stopping.
(D) The 1 kg box travels four times as far as the 4 kg box before stopping.
(E) Both boxes travel the same distance before stopping.

continued on page 7 ...

23. You wish to accelerate your car at a constant acceleration. To do this car's engine

(A) must maintain a constant power output.
(B) have a steadily decreasing power output.
(C) have an ever increasing power output.
(D) must be turning at a constant speed.
(E) must produce the same amount of energy every second.

24. A golf ball and a ping-pong ball are sliding with equal velocities over a horizontal frictionless surface. The golf ball has the greater kinetic energy because it has the greater mass. They encounter a frictionless hill and slow down as they slide up it. Which object slides to the greatest height?

(A) The golf ball because it had the greater kinetic energy.
(B) The ping-pong ball because it weighs less.
(C) Neither, they both slide to the same height.
(D) The golf ball because the work done by gravity on it will be greater.
(E) We cannot say since it depends on the slope of the hill.

25. Two electrically charged spheres with centres separated by a distance d repel each other with a force F. If the spheres are separated to a distance $2d$, the force will still be F if

(A) the charge on one sphere is increased to twice its original value.
(B) the charge on each sphere is increased to four times its original value.
(C) the charge on one sphere is reduced to one-half its original value.
(D) the charge on one sphere is increased to four times its original value.
(E) the charge on each sphere is reduced to one-half its original value.

26. An object, which has a charge of 2 Coulombs, is moved through a potential difference of 10 Volts. The magnitude of the work done on the object by the electric forces is

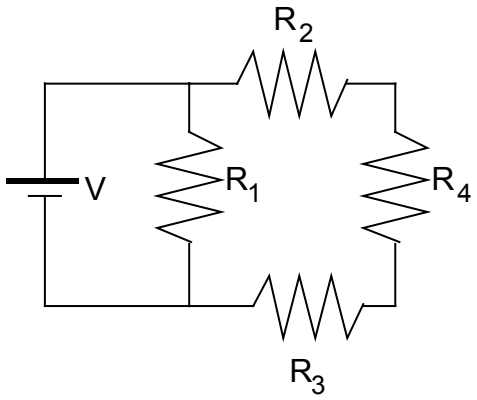
(A) 2 Joules
(B) 5 Joules
(C) 10 Joules
(D) 20 Joules
(E) 40 Joules

27. An ideal battery with voltage V is connected to two resistors, each with resistance R, wired in parallel. The current that flows from the battery is

(A) $\frac{2V}{R}$
(B) $\frac{V}{R}$
(C) $\frac{V}{2R}$
(D) $\frac{V}{4R}$
(E) $2VR$

continued on page 8 ...

28. An ideal battery drives a circuit containing 4 resistors, as shown in the diagram. If the resistance of R_4 is increased, which one of the following statements is correct?



(A) The current through R_1 increases.
(B) The power dissipated by R_3 increases.
(C) The current through R_2 decreases.
(D) The voltage across R_1 increases.
(E) The voltage across R_2 increases.

END OF EXAMINATION