UNIVERSITY OF SASKATCHEWAN

Department of Physics and Engineering Physics

High School Physics Scholarship Competition

May 7, 2003 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 7 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: _____

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

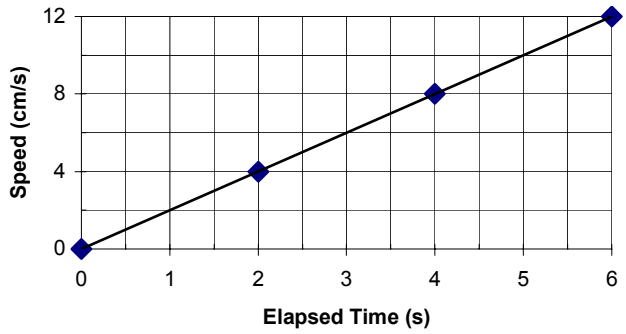
1. Which one of the following options correctly arranges the units in order of smallest to largest?

(A) m, cm, mm, km, μm
(B) m, mm, cm, μm, km
(C) mm, cm, μm, m, km
(D) μm, mm, cm, m, km
(E) μm, cm, mm, m, km

2. In an experiment, an object travels a measured straight-line distance of 36.0 cm in a measured time of 1.50 s. Which of the following options best represents the average speed of the object?

(A) 24.00 cm/s
(B) 24.0 cm/s
(C) 24.000 cm/s
(D) 24 cm/s
(E) 30 cm/s

3. The speed of an object is measured at various times and the results are plotted:



The speed of the object at an elapsed time of 3.5 s is

(A) 4.5 cm/s.
(B) 5 cm/s.
(C) 6 cm/s.
(D) 7 cm/s.
(E) 7.5 cm/s.

4. A transverse wave on a horizontal stretched string has crests that are 2 cm above the rest position of the string and troughs that are 2 cm below the rest position. The amplitude of this wave is

(A) 0 cm.
(B) 2 cm.
(C) 4 cm.
(D) 6 cm.
(E) 8 cm.

5. The speed of light in a vacuum is constant. If a light wave of frequency 5.0×10^{14} Hz has a wavelength of 600 nm, the wavelength of a light wave of frequency 7.5×10^{14} Hz is

(A) 200 nm.
(B) 300 nm.
(C) 400 nm.
(D) 750 nm.
(E) 800 nm.

6. Two waves of equal amplitude A have the same frequency and wavelength. Both waves simultaneously pass through a location P. The amplitude of the resultant wave at P

(A) is 0.
(B) is ½ A.
(C) is A.
(D) is $2A$.
(E) cannot be determined without knowing the phase difference between the two waves when they meet at P.

7. A string, fixed at both ends, is producing a standing wave interference pattern. If λ is the wavelength of the wave producing the pattern, the distance between consecutive nodes of the pattern is

(A) ¼λ.
(B) ½λ.
(C) 0.75λ.
(D) λ.
(E) 1.5λ.

8. Two identical light bulbs are emitting light uniformly in all directions. An observer notes that the intensity of light from bulb 1 is one-quarter of the intensity of light from bulb 2. The observer concludes that she is

(A) one-quarter as far from bulb 1 as from bulb 2.
(B) half as far from bulb 1 as from bulb 2.
(C) the same distance from each light bulb.
(D) twice as far from bulb 1 as from bulb 2.
(E) four times as far from bulb 1 as from bulb 2.

9. Which of the following is **not** a unit of time?

(A) second
(B) day
(C) hour
(D) light year
(E) minute

10. The speed of light in a vacuum is 3×10^8 m/s and the speed of light in a certain type of glass is 2×10^8 m/s. The index of refraction of the glass is

(A) 0.67.
(B) 1.5.
(C) 2.
(D) 3.
(E) 6.

11. An object is placed between the focus and centre of curvature of a spherical, converging mirror. The image is

(A) virtual, erect, smaller than the object.
(B) virtual, erect, larger than the object.
(C) virtual, inverted, larger than the object.
(D) real, inverted, larger than the object.
(E) real, inverted, smaller than the object.

12. Corn oil is carefully poured into a beaker containing water. The corn oil floats on the water (corn oil and water do not mix). A ray of light travelling from the corn oil into the water is observed to bend away from the normal to the corn oil-water interface. We conclude that

(A) the index of refraction of corn oil is greater than the index of refraction of water and that the speed of light in corn oil is less than the speed of light in water.
(B) the index of refraction of corn oil is greater than the index of refraction of water and that the speed of light in corn oil is greater than the speed of light in water.
(C) the index of refraction of corn oil is greater than the index of refraction of water and that the speed of light in corn oil is equal to the speed of light in water.
(D) the index of refraction of corn oil is less than the index of refraction of water and that the speed of light in corn oil is less than the speed of light in water.
(E) the index of refraction of corn oil is less than the index of refraction of water and that the speed of light in corn oil is greater than the speed of light in water.

13. The absolute temperature of an ideal gas is directly proportional to which of the following properties, when taken as an average, of the molecules of that gas?

(A) speed
(B) momentum
(C) mass
(D) kinetic energy
(E) none of the above

14. Which of the following best describes a substance in which the temperature remains constant while heat is flowing into it?

(A) gas
(B) liquid
(C) solid
(D) substance that is solidifying
(E) substance that is melting

15. What happens to a given mass of water when heated from 1 °C to 4 °C?

(A) Its density increases.
(B) Its density decreases.
(C) Its density remains the same.
(D) It begins to boil.
(E) It becomes opaque.

16. Which of the following is **not** a vector quantity?

(A) velocity
(B) force
(C) momentum
(D) acceleration
(E) mass

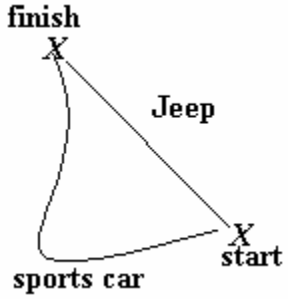
17. A hiker walks 3 km due West, then turns and walks 4 km due North. The magnitude of the hiker's displacement from his starting point is

(A) 1 km.
(B) 3 km.
(C) 4 km.
(D) 5 km.
(E) 7 km.

18. A baseball is thrown from player 1 to player 2, starting and finishing at the same height. At what point is the ball's speed at a minimum? (Ignore any effects due to air resistance.)

(A) just after leaving player 1's hand
(B) just before reaching player 2
(C) at the top of its trajectory
(D) when it is at half of the maximum height of its trajectory
(E) the ball's speed is constant throughout its flight

19. The driver of a sports car and the driver of a Jeep meet on a back road and decide to have a race. Both vehicles reach the finish point at exactly the same time, the Jeep having gone cross-country, the sports car having followed the road. Which of the following statements is correct?



(A) The average velocity of the sports car was greater than that of the Jeep.
(B) The average velocities of the two vehicles were the same.
(C) The average speeds of the two vehicles were the same.
(D) The average speed of the Jeep was greater than that of the sports car.
(E) The average speed of the sports car was the same as the magnitude of its average velocity.

20. Which one of the following statements **must** be true concerning an object moving at constant velocity?

(A) There are no forces acting on the object.
(B) There are no frictional forces acting on the object.
(C) The net force on the object is non-zero and constant.
(D) The net force on the object is non-zero and directed opposite to the object's motion.
(E) The forces acting on the object are balanced – the net force is zero.

21. If you exert a force of magnitude F on an object, the magnitude of the force that the object exerts on you will

(A) depend on the masses of you and the object.
(B) be F in all cases.
(C) depend on whether or not the object is moving.
(D) depend on whether or not you are moving.
(E) depend on whether or not friction is present.

22. Consider a simple pendulum, consisting of a mass m and a string of length L. As the pendulum swings from the equilibrium position to a position where the string makes an angle θ with the vertical, the work done on the mass by the tension force in the string is

(A) 0.
(B) mgL.
(C) $mgL\cos\theta$.
(D) $mgL\sin\theta$.
(E) $mgL\tan\theta$.

23. A 4-kg mass moving with a speed of 2 m/s and a 2-kg mass moving with a speed of 4 m/s are gliding over a horizontal frictionless surface. Both objects encounter the same constant horizontal force, which directly opposes their motion, and are brought to rest by it. Which of the following statements is correct?

(A) Both masses travel the same distance before stopping.
(B) The 2-kg mass travels twice as far as the 4-kg mass before stopping.
(C) The 2-kg mass travels farther, but not necessarily twice as far.
(D) The 4-kg mass travels twice as far as the 2-kg mass before stopping.
(E) The 4-kg mass loses more kinetic energy than the 2-kg mass.

24. Which of the following statements concerning inelastic collisions is correct?

(A) Both kinetic energy and momentum are conserved.
(B) Neither kinetic energy nor momentum are conserved.
(C) Kinetic energy is conserved but momentum is not.
(D) Momentum is conserved but kinetic energy is not.
(E) Kinetic energy is not conserved. Momentum may or may not be conserved depending on the masses of the colliding objects.

25. A neutral atom **must** have

(A) twice as many electrons as protons.
(B) twice as many protons as electrons.
(C) equal numbers of protons and neutrons.
(D) equal numbers of electrons and neutrons.
(E) equal numbers of protons and electrons.

26. A voltmeter is used to measure electric potential difference between two points in an electric circuit. Which one of the following statements is correct?

(A) The voltmeter must be connected in parallel with the circuit and it must have a low internal resistance.
(B) The voltmeter must be connected in series with the circuit and it must have a low internal resistance.
(C) The voltmeter must be connected in series with the circuit and it must have a high internal resistance.
(D) The voltmeter must be connected in parallel with the circuit and it must have a high internal resistance.
(E) The voltmeter can be connected in either parallel or series with the circuit.

27. Consider two pieces of copper wire each carrying a current of 3 A. The wires are of equal length but wire 1 has twice the diameter of wire 2. Which of the following statements is correct concerning V_1, the electric potential difference applied across wire 1, and V_2, the electric potential difference applied across wire 2?

(A) $V_1 = \frac{1}{4}V_2$
(B) $V_1 = \frac{1}{2}V_2$
(C) $V_1 = V_2$
(D) $V_1 = 2V_2$
(E) $V_1 = 4V_2$

28. When a number of different resistors are connected in series

(A) the same power is dissipated in each one.
(B) the electric potential difference across each is the same.
(C) the electric current flowing through each is the same.
(D) the total effective resistance is less than that of the resistor with the lowest resistance value.
(E) the total effective resistance equals that of the resistor with the lowest resistance value.

END OF EXAMINATION