

UNIVERSITY OF SASKATCHEWAN
Department of Physics and Engineering Physics

High School Physics Scholarship Competition

May 8, 2002

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: _____

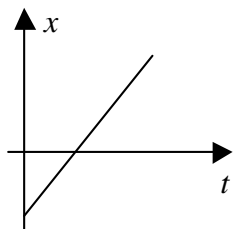
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FOR EACH OF THE FOLLOWING QUESTIONS ENTER THE MOST APPROPRIATE RESPONSE ON THE OMR SHEET.

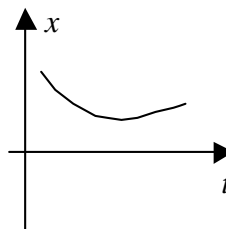
1. Consider the equation $v = \frac{1}{3} zxt^2$. The dimensions of the variables x , v , and t are [L], [L]/[T], and [T] respectively. Which one of the following correctly expresses the dimensions of z ?
 - (A) [T]
 - (B) 1/[T]
 - (C) 1/[T]³
 - (D) [L]²/[T]
 - (E) [L]² [T]
2. A length is measured and found to be 6.0 ± 0.3 cm. The percentage uncertainty in this length is
 - (A) 30%
 - (B) 3%
 - (C) 20%
 - (D) 2%
 - (E) 5%
3. Simple pendulum 1 of length 1 m and bob mass 100 g and simple pendulum 2 of length 2 m and bob mass 200 g are undergoing small-amplitude oscillations. Which one of the following statements is correct?
 - (A) The period of pendulum 2 is greater than the period of pendulum 1.
 - (B) The periods of the pendula are equal.
 - (C) The period of pendulum 2 is $\frac{1}{2}$ the period of pendulum 1.
 - (D) The period of pendulum 2 is less than $\frac{1}{2}$ the period of pendulum 1.
 - (E) Nothing can be said about the relationship between the periods without knowing the value of g .
4. A wave travels from one medium to a different medium, with a resulting decrease in the wave speed. Along with this decrease in speed there is a
 - (A) decrease in the wavelength of the wave, the frequency remaining constant.
 - (B) decrease in the frequency of the wave, the wavelength remaining constant.
 - (C) decrease in both the wavelength and frequency of the wave.
 - (D) increase in the wavelength of the wave and a decrease in its frequency.
 - (E) increase in the frequency of the wave and a decrease in its wavelength.
5. A guitar string of length L is fixed at both ends. For which of the following values of wavelength is it **not** possible to establish a standing wave pattern on the string?
 - (A) $\lambda = L$
 - (B) $\lambda = \frac{2}{3} L$
 - (C) $\lambda = \frac{1}{2} L$
 - (D) $\lambda = 4L$
 - (E) $\lambda = \frac{1}{4} L$

6. Light is radiating equally in all directions from a source. The intensity at a distance of 1 m from the source is I . The intensity at a distance of 2 m from the source is
- (A) $\frac{1}{2} I$
 - (B) $2 I$
 - (C) I
 - (D) $\frac{1}{4} I$
 - (E) $4 I$
7. The index of refraction of a certain material is 1.5. The speed of light in this material is
- (A) one-third of the speed of light in a vacuum.
 - (B) two-thirds of the speed of light in a vacuum.
 - (C) equal to the speed of light in a vacuum.
 - (D) 1.5 times the speed of light in a vacuum.
 - (E) 3 times the speed of light in a vacuum.
8. An object is positioned in front of a diverging (convex) mirror. The image formed by the mirror is
- (A) real, inverted, and smaller than the object if the object distance is greater than the radius of curvature of the mirror.
 - (B) real, inverted, and larger than the object if the object distance is greater than the radius of curvature of the mirror.
 - (C) virtual, erect, and larger than the object.
 - (D) virtual, erect, and smaller than the object.
 - (E) real, erect, and larger than the object.
9. A ray of light travelling in water strikes a water-air interface at an angle of incidence less than the critical angle. Which one of the following is correct?
- (A) All the light reflects into the water (total internal reflection).
 - (B) All the light refracts into the air.
 - (C) All the light is absorbed.
 - (D) Some of the light reflects and some refracts. The angle of refraction is less than the angle of incidence.
 - (E) Some of the light reflects and some refracts. The angle of refraction is greater than the angle of incidence.
10. By what primary heat transfer mechanism does one end of an iron bar become hot when the other end is placed in a flame?
- (A) natural convection
 - (B) conduction
 - (C) radiation
 - (D) forced convection
 - (E) none of the above

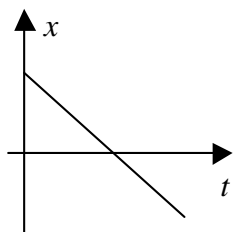
11. Convection can occur
- (A) only in solids.
 - (B) only in liquids.
 - (C) only in gases.
 - (D) only in liquids and gases.
 - (E) in solids, liquids, and gases.
12. Which position versus time graph best represents a constant, positive velocity?



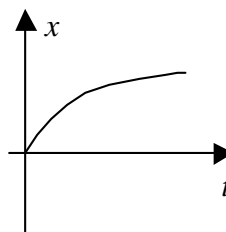
(A)



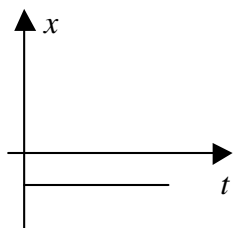
(B)



(C)



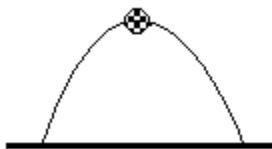
(D)



(E)

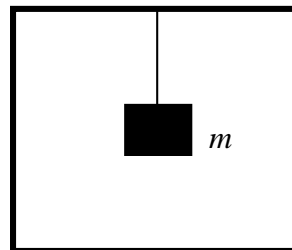
13. A vector of length 3 m and a vector of length 4 m are added. The length of the resultant vector
- (A) must be 1 m
 - (B) must be 5 m
 - (C) must be 7 m
 - (D) must be between 3 m and 4 m.
 - (E) is between 1 m and 7 m, depending on the directions of the vectors being added.

14. A motorist travels for two hours at 80 km/h and one hour at 110 km/h. What is the average speed for this trip?
- (A) 85 km/h
(B) 90 km/h
(C) 95 km/h
(D) 100 km/h
(E) 105 km/h
15. If an object has constant acceleration, its
- (A) displacement changes at a constant rate.
(B) velocity changes at a constant rate.
(C) acceleration changes at a constant rate.
(D) displacement can never be zero.
(E) velocity can never be zero.
16. An object starts from rest and undergoes a constant acceleration of magnitude a . The object moves a distance of 1 m in the first second. How far does the object move during the time interval from $t = 1$ s to $t = 2$ s? ($t = 0$ is the time when the object started moving.)
- (A) 1 m
(B) 1.5 m
(C) 2 m
(D) 3 m
(E) 4 m
17. Ball 1 is thrown horizontally from the edge of the roof of a tall building and at the same instant ball 2 is dropped over the edge from the same height. Which of the following statements is correct? Ignore any effects due to air resistance.
- (A) Ball 2 strikes the ground before ball 1.
(B) Ball 1 strikes the ground before ball 2.
(C) Both balls strike the ground at the same time, ball 1 has a greater speed than ball 2.
(D) Both balls strike the ground at the same time, ball 2 has a greater speed than ball 1.
(E) Both balls strike the ground at the same time with the same speed.
18. The figure shows the trajectory of a soccer ball that was kicked with an initial velocity v_0 at an angle θ above the horizontal. When the ball is at its maximum height above the ground:



- (A) its acceleration and its velocity are zero;
(B) its velocity is zero, its acceleration is not;
(C) its acceleration is zero, its velocity is not;
(D) neither its velocity nor its acceleration is zero;
(E) its velocity and its acceleration have the same direction.

19. A mass m is suspended by a string of negligible weight from the roof of an elevator. The tension in the string has a magnitude of mg . Which of the following statements is correct concerning the motion of the elevator?



- (A) The elevator must be moving upward and slowing down.
(B) The elevator must moving downward and speeding up.
(C) The elevator must be at rest.
(D) The elevator must be moving downward and slowing down.
(E) The elevator is either at rest or moving with constant velocity.
20. 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 acceleration of the truck is a . Therefore, during the collision, the magnitude of the average acceleration of the car is
- (A) $a/10$
(B) a
(C) $10 a$
(D) Much larger than $10 a$.
(E) Much smaller than $a/10$.
21. In an elastic collision
- (A) kinetic energy is conserved but momentum is not.
(B) neither kinetic energy nor momentum are conserved.
(C) momentum is conserved but kinetic energy is not.
(D) both kinetic energy and momentum are conserved.
(E) whether or not kinetic energy is conserved depends on the relative masses of the objects that are colliding.
22. A ball of mass m has a gravitational potential energy of 200 J when held at a height h above the Earth's surface. The ball is now released from rest from this height h . In the absence of air resistance, the kinetic energy of the ball when it has a fallen a distance $h/4$ is
- (A) 50 J
(B) 100 J
(C) 150 J
(D) 200 J
(E) impossible to determine without knowing the mass of the ball and the height h .
23. It requires 40 J of work to move a charge of 2 C from one point to another. The electric potential difference between these two points is
- (A) 40 V
(B) 20 V
(C) 80 V
(D) 160 V
(E) 10 V

24. An ammeter is used to measure current in an electric circuit. Which one of the following statements is correct?
- (A) The ammeter must be connected in parallel with the circuit and it must have a low internal resistance.
 - (B) The ammeter must be connected in series with the circuit and it must have a low internal resistance.
 - (C) The ammeter must be connected in series with the circuit and it must have a high internal resistance.
 - (D) The ammeter must be connected in parallel with the circuit and it must have a high internal resistance.
 - (E) The ammeter can be connected in either parallel or series with the circuit.
25. Consider two pieces of copper wire of equal length. The radius of wire 1 is twice that of wire 2. If the resistance of wire 2 is R , the resistance of wire 1 is
- (A) $\frac{1}{4} R$
 - (B) $\frac{1}{2} R$
 - (C) R
 - (D) $2 R$
 - (E) $4 R$
26. Two 2Ω resistors are connected in parallel across an ideal 12 V battery. The current drawn from the battery is
- (A) 3 A
 - (B) 6 A
 - (C) 9 A
 - (D) 12 A
 - (E) 24 A
27. An electric heater produces energy at a rate of 400 W when connected to a 110-V outlet. When connected to a 220-V outlet, the power output of the heater will be
- (A) 200 W
 - (B) 800 W
 - (C) 440 W
 - (D) 1200 W
 - (E) 1600 W

END OF EXAMINATION