UNIVERSITY OF SASKATCHEWAN

Department of Physics and Engineering Physics

2009 Saskatchewan High School Physics Scholarship Competition

May 6, 2009 Time: 90 minutes

This competition is based on the Saskatchewan High School Physics 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: _____

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_____

Postal Code: _____

Telephone: _____

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

Note: In all the questions the symbol *g* denotes the magnitude of the acceleration due to gravity on the Earth's surface.

1. Which one of the following calculations has an answer that can be expressed correctly to 4 significant figures?

(A) 0.0145 m + 1.66 m
(B) $(2.998 \times 10^6 \text{ m/s}) \times (2.01 \times 10^2 \text{ s})$
(C) 0.003380 s + 0.000036 s
(D) 3.674 m – 0.22 m
(E) (105 km) ÷ (65 km/h)

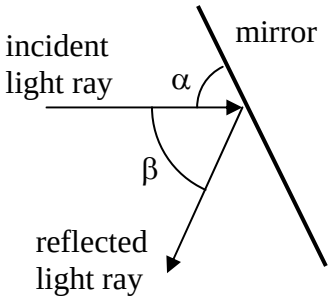
2. A wave in which the motion of the medium carrying the wave is perpendicular to the direction of travel of the wave is called a

(A) harmonic wave.
(B) transverse wave.
(C) travelling wave.
(D) longitudinal wave.
(E) sound wave.

3. A periodic wave moves along a stretched spring at a speed of 20 m/s. As the waves passes by a place on the spring oscillates from side to side at a rate of 10 times per second. What is the wavelength of the wave moving along the spring?

(A) 200 m.
(B) 10 Hz.
(C) 0.50 m.
(D) 2.0 m.
(E) 0.10 s.

4. When the angle, α, between an incident light ray and the surface of a mirror is 15°, the angle, β, between the reflected ray and the incident ray is



(A) 30°
(B) 60°
(C) 120°
(D) 150°
(E) 165°

5. When light traveling in medium 1 is incident on the boundary between medium 1 and medium 2 we observe that there is total internal reflection. From this we can deduce that

(A) the speed of the light in medium 1 is smaller than in medium 2.
(B) the index of refraction in medium 1 is smaller than in medium 2.
(C) the frequency of the light in medium 1 is greater than in medium 2.
(D) the wavelength of the light in medium 1 is greater than in medium 2.
(E) None of the above statements are true.

6. When a guitar string, which is fixed at both ends, is plucked in the normal way the note you hear corresponds to the fundamental frequency, f_0, of the vibrating string. By being clever about the way you pluck the string it is possible to make the guitar string vibrate in a mode where there is a single node that is half way between the fixed ends of the guitar string. In this case the note you hear will have a frequency of

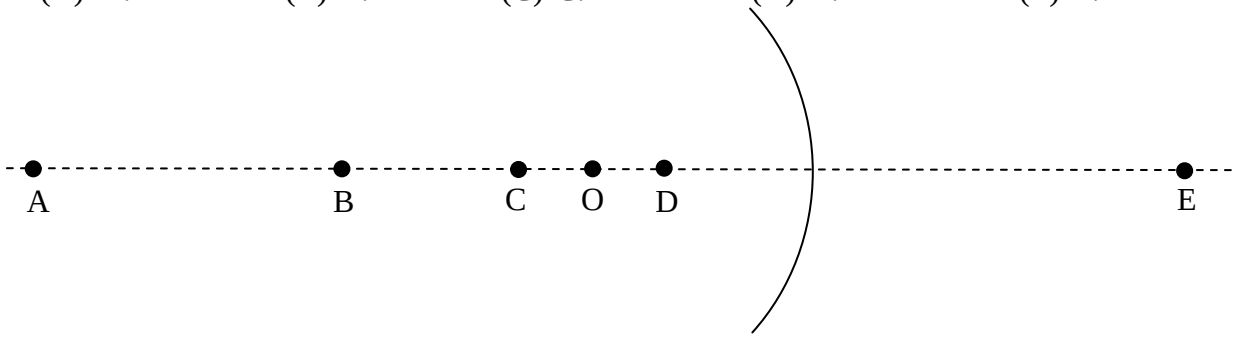
(A) $\frac{1}{4} f_0$
(B) $\frac{1}{2} f_0$
(C) $2 f_0$
(D) $3 f_0$
(E) $4 f_0$

7. Jupiter is approximately 5 times further from the Sun than is the Earth. When the Voyager spacecraft was near the Earth at the start of its journey, the intensity of the light from the Sun hitting its solar panel was *I*. When it reached Jupiter the intensity of the Sun's light hitting the solar panel was then approximately

(A) $\frac{1}{5} I$
(B) $\frac{1}{10} I$
(C) $\frac{1}{25} I$
(D) $\frac{1}{50} I$
(E) $\frac{1}{100} I$

8. The diagram below shows a concave mirror. The centre of curvature of the mirror is at the point labelled C. If an object is placed at the point labelled O, the image of the object would be located at the point labelled

(A) A. (B) B. (C) C. (D) D. (E) E.



9. The image produced on the retina of the normal human eye by a distant, upright object would be described as

(A) virtual and upright.
(B) real and upright.
(C) virtual and inverted.
(D) real and inverted.

10. Which one of the following is **not** electromagnetic radiation?

(A) Visible Light.
(B) Microwaves.
(C) Gamma rays.
(D) Ultrasonic Waves.
(E) Ultraviolet Light.

11. The specific heat capacity of water is 2 times larger than the specific heat of ice. If the energy needed to change the temperature of 1 kg of ice from –10°C to –5°C is Q, how much energy is needed to change the temperature of 1 kg of water from 0°C to 10°C?

(A) $\frac{1}{4}Q$
(B) $\frac{1}{2}Q$
(C) Q
(D) $2Q$
(E) $4Q$

12. Turning up the flame under a pan of boiling water causes

(A) the water to boil away faster, while the water's temperature remains the same.
(B) the temperature of the boiling water to increase, but it boils away at the same rate.
(C) the temperature of the boiling water to increase, and it boils away faster.
(D) the temperature of the boiling water to increase, but it might boil away faster or slower depending on other conditions.

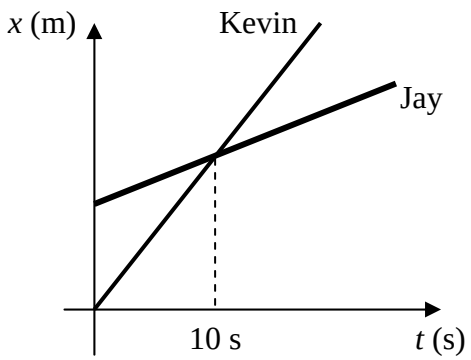
13. Which one of the following quantities related to a sound wave is most closely related to the characteristic of a sound that is measured in the units known as Decibels?

(A) Wavelength.
(B) Frequency.
(C) Velocity.
(D) Amplitude.
(E) Pitch.

14. A bat flying quickly towards a solid cliff wall emits a shriek. The bat hears the shriek reflected back towards him from the cliff wall. The pitch of the reflected shriek will be

(A) higher than the shriek he emitted.
(B) the same as the shriek he emitted.
(C) lower than the shriek he emitted.
(D) lower or higher than the shriek he emitted depending on the speed at which he is flying.

15. The graph describes the motion of two cyclists, Jay and Kevin, moving along a straight road (the *x*-axis). At the time $t = 10$ s



(A) Jay has greater velocity than Kevin.
(B) Kevin has greater velocity than Jay.
(C) Jay and Kevin have the same velocity.
(D) Jay is accelerating.
(E) Kevin is accelerating.

16. An object is accelerating. Which of the following statements must be true?

(A) The object's velocity is increasing in magnitude.
(B) The object's speed is increasing.
(C) The object's speed is changing.
(D) The object is changing direction.
(E) The object's velocity is changing.

17. A woman drives her car at a speed of 60 km/h for 2 hours. Then she speeds up to 90 km/h and travels at that speed for another 1 hour. What is the woman's average speed for the whole trip?

(A) 50 km/h
(B) 70 km/h
(C) 75 km/h
(D) 80 km/h
(E) Cannot be determined.

18. A ball is thrown horizontally from the top of a bridge at the same time as a stone is dropped from the top of the bridge. Both hit the water below. If the effects of air resistance can be neglected, which one of the following statements is correct?

(A) The stone and the ball hit the water at the same time, but the stone has the greater speed when it hits.
(B) The stone and the ball hit the water at the same time, but the ball has the greater speed when it hits.
(C) The stone and the ball hit the water at the same time, and they both have the same speed when they hit.
(D) The ball hits the water before the stone, and its speed when it hits is greater than the speed with which the stone hits the water.
(E) The stone hits the water before the ball, and its speed when it hits is greater than the speed with which the ball hits the water.

19. A decoration, of mass *M*, is suspended by a light string from the ceiling of an elevator. When the elevator is moving upward with a constant speed, what can we say about the tension in the string?

(A) We can make no statement without knowing the speed of the elevator.
(B) It must be greater then *Mg*.
(C) It must be smaller than *Mg*.
(D) It must be equal to *Mg*.

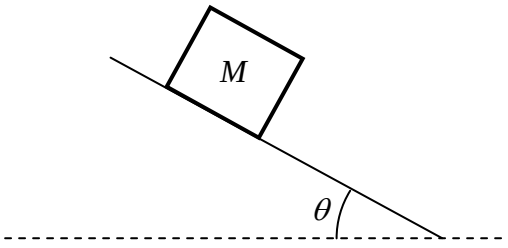
20. An object is dropped from a helicopter. When the object reaches its terminal velocity before hitting the ground

(A) the object's acceleration has finally reached *g*.
(B) gravity no longer acts on the object.
(C) the net force on the object is zero.
(D) the acceleration due to gravity becomes zero.
(E) the force of air resistance on the object becomes zero.

21. A baseball is hit by a baseball bat. Just before the bat hits the ball, the ball is moving very much faster than the speed of the bat. At some instant during the collision between the ball and the bat the magnitude of the force of the bat on the ball is 1000 N. At that same instant the magnitude of the force of the ball on the bat is

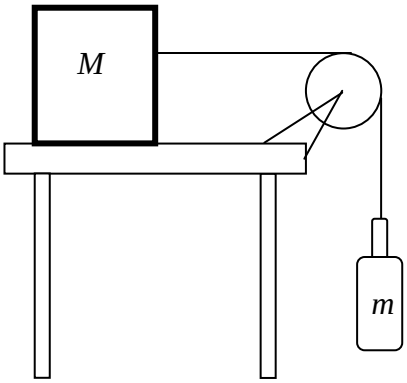
(A) also 1000 N.
(B) somewhat less than 1000 N.
(C) somewhat greater than 1000 N.
(D) essentially zero.
(E) We do not have enough information to make a statement.

22. A block of mass *M* is sliding down a frictionless ramp which is inclined at an angle of θ to the horizontal. The magnitude of the net force on the block is



(A) zero.
(B) Mg.
(C) $Mg\sin\theta$.
(D) $Mg\cos\theta$.
(E) $Mg\tan\theta$.

23. A box, of mass *M*, on a horizontal table top is connected with a string over a pulley to a bottle, of mass *m*. The pulley has negligible turning friction. The coefficient of static friction between the box and the table top is μ_s. When the system is released the box does not slide. The magnitude of the horizontal friction force on the box must be



(A) $\mu_s Mg$
(B) $\mu_s mg$
(C) mg
(D) Mg
(E) $\mu_s(M+m)g$

24. A mass, *M*, is initially at rest on a horizontal frictionless surface. It is then pushed with a horizontal force of magnitude *F* until the mass has moved a distance *d*. After it has moved the distance *d* the speed of the mass is

(A) Fd

(B) $\frac{Fd}{M}$

(C) $\sqrt{\frac{Fd}{M}}$

(D) $\sqrt{\frac{2Fd}{M}}$

(E) $\frac{2F}{Md}$

25. A truck of mass *M* which is moving with a speed *v* collides with a stationary car of mass *m*. After the collision the two vehicles are locked together and move as one. What is the speed of the wreck just after the collision?

(A) $\frac{Mv}{(M+m)}$

(B) $\frac{mv}{(M+m)}$

(C) $\frac{mv}{M}$

(D) $\frac{Mv}{m}$

(E) $\frac{(M+m)v}{M}$

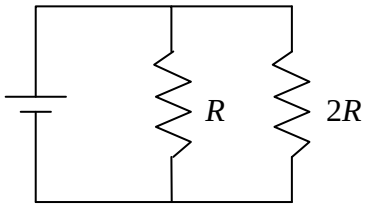
26. A boy on a toboggan starts from rest from the top of a snow covered hill. When he reaches the bottom he has a speed of 4 m/s. Later his mother gets on the toboggan and also starts from rest from the top of the same hill. The weight of the boy plus toboggan is one half of the weight of his mother plus toboggan. The effects of friction between the toboggan and the snow can be neglected. When his mother reaches the bottom of the hill she has a speed of

(A) 1 m/s.
(B) 2 m/s.
(C) 4 m/s.
(D) 8 m/s.
(E) 16 m/s.

27. The acceleration due to gravity on the surface of the Moon is about one sixth of the acceleration due to gravity on the surface of the Earth. We can conclude that

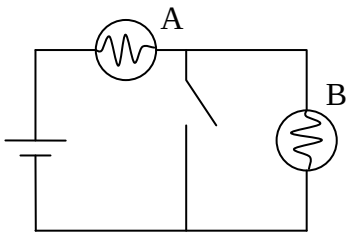
(A) The mass of the Moon is about one sixth of the mass of the Earth.
(B) The radius of the Moon is about one sixth of the radius of the Earth.
(C) The radius of the Moon is about six times the radius of the Earth.
(D) The mass of the Moon is about one sixth of the mass of the Earth and the radius of the Moon is about one sixth of the radius of the Earth.
(E) None of the above conclusions can be reached.

28. Two resistors, one with resistance R and the other with resistance $2R$ are connected in parallel with a battery as shown. The potential difference across the resistance $2R$ is



(A) 4 times the potential difference across the resistance R.
(B) 2 times the potential difference across the resistance R.
(C) the same as the potential difference across the resistance R.
(D) one half the potential difference across the resistance R.
(E) one quarter the potential difference across the resistance R.

29. Two identical light bulbs are connected to an ideal battery in the circuit shown. Initially the switch is open. What happens to the brightness of the bulbs when the switch is closed?



(A) Bulb A and bulb B get dimmer.
(B) Bulb A gets brighter and bulb B goes out.
(C) Bulb A stays the same brightness and bulb B goes out.
(D) Bulb A gets brighter and bulb B stays the same brightness.
(E) Both bulbs stay the same brightness.

30. The half-life of a particular isotope of copper is 10 minutes. This means that if there are initially N_0 atoms of this isotope there will be only half of them remaining after 10 minutes. If we were to wait 30 minutes, how many of the initial N_0 atoms would remain?

(A) none
(B) $\frac{1}{4}N_0$
(C) $\frac{1}{8}N_0$
(D) $\frac{1}{12}N_0$
(E) $\frac{1}{16}N_0$

END OF EXAMINATION