PHYSICSBOWL 2026

March 18 – April 3, 2026

40 QUESTIONS – 45 MINUTES

The 2026 PhysicsBowl, organized by the **American Association of Physics Teachers**, is an opportunity to recognize outstanding high school physics students and their teachers through their performance on this year's contest.

- Schools compete in one of two divisions, each with nineteen regions.
  - *Division 1* is for students *taking physics for the first time* (even if that first course is AP Physics).
  - *Division 2* is for students taking a second (or more) course in physics OR anyone wanting a challenge.
- A school's team score in each division is the sum of the ***five*** highest student scores in that division.
- A school may compete in either or both divisions.

INSTRUCTIONS

Answer sheet: Write and bubble-in the following **REQUIRED** information on your answer sheet:

- Your *Name*
- Your *Teacher's AAPT Teacher code* (given to you by your teacher – only ***one*** code per school!)
- Your *Region* (given to you by your teacher)
- Your *Division* (1 for first-year physics students, 2 for students in a 2nd physics course OR wanting a challenge)

If this information is not properly bubbled, ***you will be disqualified,*** as your official score will be a zero.

Your *School's CEEB code* (given to you by your teacher), though not required, is helpful in the event of a disqualification for identifying your school.

Your answer sheet will be machine graded. Be sure to use a *#2 pencil*, fill the bubbles completely, and make no stray marks on the answer sheet.

Questions: The test is composed of 50 questions; however, students answer only 40 questions.

Division 1 students will answer only questions 1 – 40. Do not answer questions 41 – 50.

Division 2 students will answer only questions 11 – 50. Do not answer questions 1 – 10.

Calculator: A hand-held calculator may be used. Any memory must be cleared of data and programs. Calculators may not be shared.

Formulas and constants: Only the formulas and constants provided with the contest may be used.

Time limit: *45 minutes.*

Score: Your score is equal to the number of correct answers (no deduction for incorrect answers). If there are tie scores, the entries will be compared from the end of the test forward until the tie is resolved. Thus, the answers to the last few questions may be important in determining the winner and you should consider them carefully.

Good Luck!

DIVISION 1 STUDENTS

START HERE.

DIVISION 2 STUDENTS

Go to question #11 on page 4.

Treat $g = 10.0\ \frac{m}{s^2}$ for ALL questions.

1. How many millimeters are in a centimeter?
   a. 1000 b. 100 c. 10 d. 0.1 e. 0.001

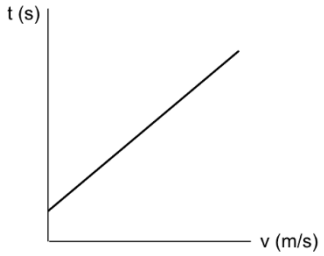
2. A point mass moving only along the x-axis increases its speed uniformly from $10\ \frac{m}{s}$ to $20\ \frac{m}{s}$ over a distance of $30.0\ m$. How much time does this change in motion take?
   a. $5.0\ s$ b. $4.0\ s$ c. $3.0\ s$ d. $2.0\ s$ e. $1.0\ s$

3. The period of a simple pendulum is doubled. Which change could cause this?
   a. doubling mass
   b. quadrupling mass
   c. quadrupling the length
   d. decreasing length by 50%
   e. doubling gravity

4. A constant force F acts on an object of mass m that is moving with an initial velocity v_0. The force acts in the same direction as the motion for a time interval Δt. What is the magnitude of the change in the object's linear momentum during this time?
   a. $F\Delta x$ b. $F\Delta t$ c. $\frac{F\Delta t}{m}$ d. $mF\Delta t$ e. $\frac{F\Delta x}{m}$

5. After a 60 kg boulder has begun its vertical fall toward the Earth, it is found that its speed is $20\ \frac{m}{s}$. What is the speed of the Earth toward the boulder at this time?
   a. $2.4 \times 10^{-22}\ \frac{m}{s}$
   b. $3.5 \times 10^{-33}\ \frac{m}{s}$
   c. $2.0 \times 10^{-22}\ \frac{m}{s}$
   d. $3.0 \times 10^{-33}\ \frac{m}{s}$
   e. $4.0 \times 10^{-33}\ \frac{m}{s}$

6. The graph at right shows the time at which an object has certain velocities. The slope of the graph best represents…
   a. Δx d. $\frac{1}{a}$
   b. v e. $\frac{1}{v}$
   c. a

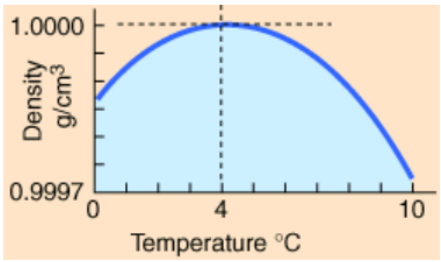


7. The Bremen Drop Tower allows experimenters to simulate microgravity by dropping capsules containing the experiment. To maximize the microgravity experiment time to 9.3 s, experimenters can launch the capsule and catch it when it returns to the launching point. If the tower were transplanted to a planet where g = 4.9 $\frac{m}{s^2}$ with the same capsule and the same maximum achievable height, determine the maximum microgravity experiment time experimenters could achieve on that planet. Assume air resistance is negligible in both towers.
   a. 4.7 s b. 9.3 s c. 13 s d. 19 s e. 27 s

8. A 70 kg student is standing on a scale inside an elevator. At time t_1, the elevator is accelerating upward with a magnitude of 1.5 $\frac{m}{s^2}$. A short time later, at time t_2, the elevator is accelerating downward with a magnitude of 1.5 $\frac{m}{s^2}$. The ratio of the scale reading (normal force) at time t_1, to the scale reading (normal force) at time t_2, is most nearly:
   a. 13: 10 b. 1: 1 c. 7: 5 d. 23: 17 e. 28:11

9. Two ice skaters push off from each other. Skater A has mass of 50 kg, skater B has mass of 75 kg. If skater A moves away at 2 m/s, what is the speed of skater B?
   a. 0.67 $\frac{m}{s}$ b. 1.33 $\frac{m}{s}$ c. 2.0 $\frac{m}{s}$ d. 2.5 $\frac{m}{s}$ e. 3.0 $\frac{m}{s}$

10. Which of the following explains why water freezes on the top first?
    a. Water freezes at 0°C
    b. Water has a molecular weight of 18 $\frac{g}{mol}$
    c. Water reaches maximum density at 4 °C
    d. Water has a density of 1 $\frac{g}{cm^3}$
    e. Water has impurities at the top



DIVISION 1 STUDENTS

Continue

Answer questions #11 through #40.

DIVISION 2 STUDENTS

START HERE

Numbers 1 – 10 on your answer sheet should be blank. Your first answer should be for #11.

Treat $g = 10.0\ \frac{m}{s^2}$ for ALL questions.

11. A ball is launched up into the air from the ground, reaches a maximum height, then falls back down to the ground; air resistance is present and non-negligible. How does the time it takes the ball to rise compare to the time it takes the ball to fall?
    a. The ball takes the same amount of time to rise as it does to fall.
    b. The ball takes more time to fall than it does to rise.
    c. The ball takes more time to rise than it does to fall.
    d. The answer depends on the initial launch speed.
    e. This question cannot be answered with the information given.

12. Two blocks of masses m and $3m$ are connected by a light rope and pulled across a frictionless surface by a force F applied to the smaller block. What is the tension in the rope?
    a. $\frac{F}{4}$ b. $\frac{F}{3}$ c. $\frac{3F}{4}$ d. F e. $\frac{3F}{2}$

13. As a star cools, the peak wavelength of the radiation it emits will…
    a. shift to shorter wavelengths
    b. shift to longer wavelengths
    c. remain constant
    d. oscillate between long and short wavelengths
    e. increase only if luminosity also decreases

14. A 1200-kg car coasts down a 15° incline that is 150 m long, starting at 30 $\frac{m}{s}$ and reaches the bottom moving at 40 $\frac{m}{s}$. Assume constant air resistance. What is the magnitude of the average resistive force?
    a. 305 N b. 370 N c. 420 N d. 480 N e. 610 N

15. A rod of length 2 m and mass 4 kg rotates about one end at 3.0 $\frac{rad}{s}$. What is its rotational kinetic energy?
    a. 6 J b. 12 J c. 18 J d. 24 J e. 36 J

16. On November 28, 1967, Jocelyn Bell, a postgraduate student at Cambridge University, discovered a new astronomical body. What did she discover?
    a. A black hole
    b. A pulsar
    c. Pluto
    d. Comet Hale-Bopp
    e. A supernova

17. A light ray passes from glass (n = 1.5) into air (n = 1.0). Which is true?
    a. It bends toward the normal
    b. It bends away from the normal
    c. It does not bend
    d. It stops at the boundary
    e. It reflects completely at any angle

18. An ideal gas is compressed so that its volume decreases by half while pressure doubles. What happens to its temperature?
    a. Decreases
    b. Stays the same
    c. Doubles
    d. Quadruples
    e. Impossible to determine without more data

19. A planet in elliptical orbit has speed v_a at aphelion and v_p at perihelion. Which is true?
    a. $v_a > v_p$
    b. $v_a = v_p$
    c. $v_a < v_p$
    d. ratio depends only on eccentricity
    e. ratio depends only on semimajor axis

20. A mass *m* moves in a circle of radius *R* on a table, attached through a frictionless hole to a hanging mass *M*. The hole is in the center of the circular path. The system rotates at angular speed ω. What upward force does *M* experience?
    a. Mg
    b. $Mg - mR\omega^2$
    c. $Mg + mR\omega^2$
    d. $mR\omega^2$
    e. $M\omega^2 R$

21. An incompressible fluid is flowing in a pipe. It then enters a section of the pipe where the radius is half of the original. What happens to its speed?
    a. speed doubles
    b. speed quadruples
    c. speed halves
    d. speed becomes ¼
    e. no change

22. A projectile of mass m embeds in a block of mass M. The block slides a distance d on friction coefficient μ. What was the projectile's initial speed?
    a. $\sqrt{\frac{2\mu g d}{\frac{m}{M}}}$
    b. $\frac{(M+m)}{m}\sqrt{2\mu g d}$
    c. $\frac{m}{M}\sqrt{2\mu g d}$
    d. $\sqrt{2\mu g d\left(1+\frac{m}{M}\right)}$
    e. $\frac{M}{M+m}\sqrt{2\mu g d}$

23. A mass moves from radius R to 2R from the center of a planet. Change in gravitational potential energy?
    a. $-\frac{GMm}{R}$ b. $+\frac{GMm}{2R}$ c. $+\frac{GMm}{2R}\ln 2$ d. $GMm\left(\frac{1}{R}-\frac{1}{2R}\right)$ e. $GMm\left(\frac{1}{2R}-\frac{1}{R}\right)$

24. Two masses *m* and *3m* connected by rod *L*. What is the distance of center-of-mass from mass *m*?
    a. $\frac{L}{2}$ b. $\frac{L}{3}$ c. $\frac{L}{4}$ d. $\frac{3L}{4}$ e. $\frac{2L}{3}$

25. A spring with spring constant *k* is compressed a distance *x* from its equilibrium position. What is the ratio of the elastic potential energy stored in the spring when it is compressed a distance *2x* to the energy stored when it is compressed a distance *x*?
    a. 1:1 b. 2:1 c. 4:1 d. $\sqrt{2}:1$ e. 1:2

26. A transverse wave is traveling on a string. Which of the following characteristics of the wave depends only on the medium (the string) and not on the frequency of the wave source?
    a. Wavelength b. Frequency c. Period d. Amplitude e. Speed

27. The area under a force-displacement graph represents which physical quantity?
    a. Work b. Impulse c. Momentum
    d. Power e. Acceleration

28. Astrophysicists can identify the elements in the outer layers of a star by studying its…
    a. Doppler effect.
    b. molecular structure.
    c. temperature.
    d. spectrum.
    e. luminosity.

29. For a reversible isothermal process on an ideal gas, which one of the following statements is correct about it?
    a. The heat exchanged with the gas is $0\,J$.
    b. The work done on the gas is $0\,J$.
    c. The volume change of the gas is $0\,m^3$.
    d. The entropy change of the gas is $0\,\frac{J}{K}$.
    e. The temperature change of the gas is $0\,K$.

30. A figure skater spins with her arms extended has an angular speed of 2 $\frac{rad}{s}$ and moment of inertia of 5 kg·m². She then pulls her arms in, reducing the moment of inertia to 2 kg·m². What is her new angular speed?
    a. 4 $\frac{rad}{s}$ b. 5 $\frac{rad}{s}$ c. 5.5 $\frac{rad}{s}$ d. 6 $\frac{rad}{s}$ e. 8 $\frac{rad}{s}$

31. A block floats in a liquid. If the density of the liquid doubles, the fraction of the block submerged:
    a. Doubles
    b. Halves
    c. Stays the same
    d. Quadruples
    e. Becomes zero

32. As more lamps are connected in parallel in a circuit, the current in the power source…
    a. increases.
    b. decreases.
    c. remains much the same.
    d. changes unpredictably.
    e. more information is needed.

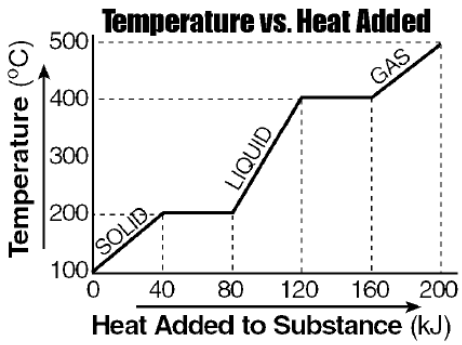
33. A 2 kg block slides down a frictionless incline of height 5 m and then compresses a horizontal spring (k = 800 $\frac{N}{m}$) at the bottom. The spring is initially at its natural length. Assuming all the block's gravitational potential energy is converted into spring potential energy at maximum compression, what is the maximum compression of the spring?
    a. 0.25 m b. 0.35 m c. 0.50 m d. 0.55 m e. 0.75 m

34. The James Webb Space Telescope was launched on December 25, 2021, and arrived at its destination, LaGrange Point 2, on January 24, 2022. This is approximately 1,500,000 km from the Earth where it will orbit the sun. How much time does it take for a transmission from the JWST to reach a receiver on the Earth?
    a. 5.0 s b. 0.5 s c. 0.05 s d. 50 s e. 500 s

35. Two charged particles are released from rest. Immediately after they are released, both increase in speed. Therefore, the particles have
    a. the same type of charge.
    b. opposite types of charge.
    c. either the same or opposite types of charge.
    d. no charge.
    e. more information is needed to determine the type of charge on the particles.

36. A 0.015 kg ball is shot from the plunger of a pinball machine. Because a centripetal force of 0.028N is acting on the ball, it follows a circular arc whose radius is 0.25 m. What is the speed of the ball?
    a. 0.04 $\frac{m}{s}$ b. 0.37 $\frac{m}{s}$ c. 0.47 $\frac{m}{s}$ d. 0.68 $\frac{m}{s}$ e. 2.16 $\frac{m}{s}$

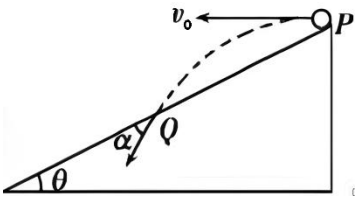
37. The graph at right shows the relationship between the temperature of 1.0 kg of a pure substance and the heat energy added to the substance. What is the heat of fusion of the substance?



a. $120\ \frac{kJ}{kg}$
b. $160\ \frac{kJ}{kg}$
c. $40\ \frac{kJ}{kg}$
d. $80\ \frac{kJ}{kg}$
e. $100\ \frac{kJ}{kg}$

38. A block of mass m is pulled a distance d up a rough incline of angle θ by a **constant horizontal force** F. The coefficient of kinetic friction is μ_k. What is the total work done **by the horizontal force**?
a. $Fd\cos\ \theta$
b. $Fd\cos\ (90^\circ - \theta)$
c. $Fd\cos\ \theta - \mu_k mgd\cos\ \theta$
d. $Fd\cos\ \theta + Fd\sin\ \theta$
e. $Fd\cos\ \theta - mgd\sin\ \theta$

39. As shown in the figure, from the top point P of a sufficiently long incline that makes an angle θ with the horizontal, a small ball is thrown horizontally with speed v_0. It lands at some point Q on the incline. The velocity of the ball when it lands on the incline makes an angle α with the surface of the incline. If the initial speed is changed to $3v_0$ and the ball still lands on the incline, which of the following statements is correct?



a. The angle α will become larger.
b. The time the ball spends in the air does not change.
c. The angle α is independent of the magnitude of the initial speed.
d. The distance between $P$and Q becomes three times its original value.
e. When the initial speed is changed to $3v_0$, the ball will no longer land on the incline.

40. A pendulum is constructed with a 1.0 m long uniform rod whose mass is 12 kg. It is free to move on a pivot at the top of the pendulum. It starts at rest in a stable equilibrium and its swing is initiated by a small sticky ball m=2.0 kg moving horizontally towards the bottom of the pendulum. With what minimum speed must the ball strike the rod so that it can make a full revolution.

a. $42\ \frac{m}{s}$ b. $2\ \frac{m}{s}$ c. $14\ \frac{m}{s}$ d.$10\ \frac{m}{s}$ e. $22\ \frac{m}{s}$

DIVISION 1 STUDENTS

STOP HERE

Your last answer should be for #40. Numbers 41-50 should remain blank for Division 1 students.

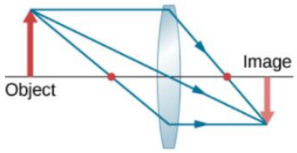
DIVISION 2 STUDENTS

CONTINUE

Answer questions #41 through #50.

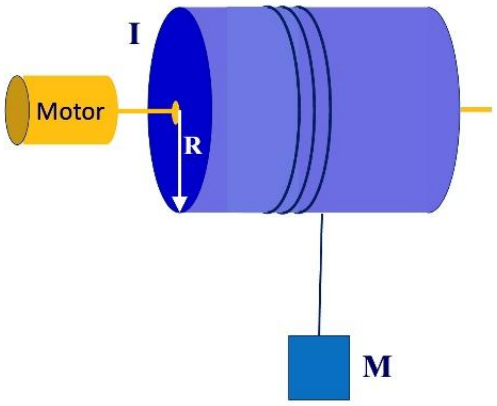
Treat $g = 10.0\ \frac{m}{s^2}$ for ALL questions.

41. A focused, real image appears on a screen when a lens is placed between an object and screen, 20.0 cm from the object. Using the same lens, another focused, real image appears on the screen when the lens is 30.0 cm from the object. What is the focal length of the lens?



a. 50.0 cm b. 25 cm c. 16 cm d. 12.0 cm e. 10.0 cm

42. One end of a string of negligible mass is wrapped around a solid cylinder (serving as a pulley) with radius *R* and rotational inertia *I*. The other end is attached to a hanging block of mass *M*. A motor applies a torque τ on the cylinder, causing it to rotate and lift the block with an upward acceleration a. Assuming the string does not slip, which of the following equations accurately represents this scenario and could be used to solve for the angular acceleration α of the cylinder?



a. $\tau - M(g + a)R = I\alpha$
b. $\tau - MgR = I\alpha$
c. $\tau - MaR = I\alpha$
d. $\tau + MaR^2 = I\alpha$
e. $\tau + MgR = I\alpha$

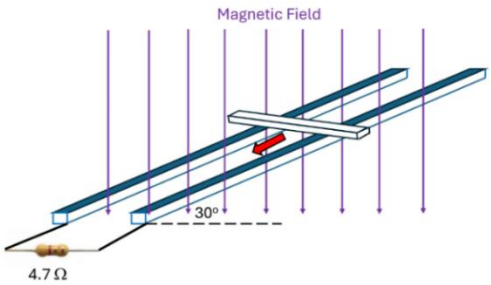
43. A box of mass *m* is given an initial speed *v* and slides along a horizontal surface. The coefficient of kinetic friction between the box and the surface is μ. The box stops after sliding a distance *d*. The stopping distance, *d*, would be doubled if which of the following quantities were doubled?
    a. only the mass of the box
    b. only the initial speed of the box
    c. only the coefficient of friction between the box and the surface
    d. only the mass of the box and the coefficient of friction between the box and the surface
    e. only the initial speed of the box and the coefficient of friction between the box and the surface.

44. Identical balls oscillate with the same period *T* on Earth. Ball **A** is attached to an ideal spring and ball **B** swings back and forth to form a simple pendulum. These systems are now taken to the Moon, where $g = 1.6\frac{m}{s^2}$, and set into oscillation. Which of the following statements about these systems are true? (There could be more than one correct choice.)
    a. Both systems will have the same period on the Moon as on Earth.
    b. On the Moon, ball **A** will take longer to complete one cycle than ball **B**.
    c. On the Moon, ball **B** will take longer to complete one cycle than ball **A**.
    d. On the Moon, ball **A** will execute more vibrations each minute than ball **B**.
    e. On the Moon, ball **B** will execute more vibrations each minute than ball **A**.

45. An electromagnetic wave in free space has electric field amplitude E_0. What is the **ratio of the average electric energy density to the average magnetic energy density**?
    a. $\frac{1}{2}$ b. 2 c. 1 d. c e. $\frac{1}{c}$

46. Resistors R_1 and R_2 with $R_1 < R_2$ have an equivalent resistance of 72.0 Ω when connected in series. What is the value of R_2 if the equivalent resistance is 16.0 Ω when R_1 and R_2 are connected in parallel?
    a. 63.0 Ω b. 54.0 Ω c. 48.0 Ω d. 42.0 Ω e. 39.0 Ω

47. A perfectly conducting rigid rod with a mass of 0.5 kg and a length of 1.2 m is free to slide without friction down two parallel, perfectly conducting rails inclined at an angle of 30° to the horizontal. The rails are connected at the bottom by a resistor with R=4.7 Ω, forming a closed circuit. The entire assembly is immersed in a uniform, vertical magnetic field of 2.0 T, as shown in the figure. If the rod is released from rest and the incline is sufficiently long, calculate the terminal velocity of the rod as it slides down the rails



    a. $2.3\frac{m}{s}$ b. $0.9\frac{m}{s}$ c. $4.7\frac{m}{s}$ d. $8.1\frac{m}{s}$ e. $12.2\frac{m}{s}$

48. What are the dimensions of voltage?
    a. $\frac{ML^2}{QS^2}$ b) $\frac{ML^2}{IS^3}$ c) $\frac{ML^2}{S^2}$ d) $\frac{ML^2}{S^3}$ e) $\frac{M^2LQ}{S^2}$

49. A horizontal tube narrows from cross-sectional area A_1 to A_2. The fluid is incompressible with density ρ. The pressure difference $\Delta P = P_1 - P_2$ is:
    a. $\frac{1}{2}\rho(A_2/A_1)^2$
    b. $\frac{1}{2}\rho v_1^2(1 - A_1/A_2)$
    c. $\frac{1}{2}\rho v_1^2(1 - (A_1/A_2)^2)$
    d. $\frac{1}{2}\rho v_1^2(1 - (A_2/A_1)^2)$
    e. $\rho v_1^2(A_2/A_1)$

50. An alpha particle (mass 6.64×10^{-27} kg) has kinetic energy $KE = 1.6 \times 10^{-14}$ J. What is its linear momentum (in $\frac{kg \cdot m}{s}$)?
    a. 1.5×10^{-20}
    b. 3.3×10^{-20}
    c. 4.6×10^{-20}
    d. 7.3×10^{-20}
    e. 1.0×10^{-19}