Twentieth SLAPT Physics Contest
Southern Illinois University Edwardsville
April 30, 2005

Senior Physics Test

$$k = \frac{1}{4\pi\varepsilon_o} = 9 \times 10^9 \ \frac{Nm^2}{C^2}$$

1. A car travels 40 kilometers at an average speed of 80 km/h and then travels 40 kilometers at an average speed of 40 km/h. The average speed of the car for this 80-km trip is:

A. 40 km/h
B. 45 km/h
C. 48 km/h
D. 53 km/h
E. 80 km/h

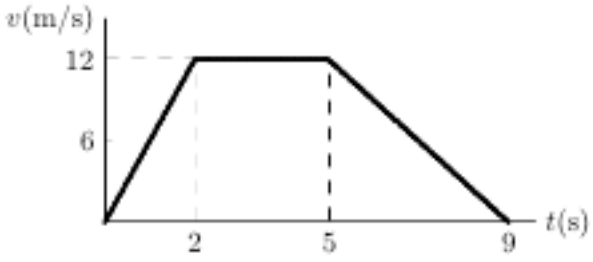
2. Each of four particles move along an x axis. Their coordinates (in meters) as functions of time (in seconds) are given by

Particle 1: $x(t) = 3.5 - 2.7t^3$
Particle 2: $x(t) = 3.5 - 3.4t^2 - 2.7t^3$
Particle 3: $x(t) = 3.5 + 2.7t^2$
Particle 4: $x(t) = 3.5 - 3.4t - 2.7t^2$

Which of these particles have constant acceleration?

A. All four
B. Only 1 and 2
C. Only 2 and 3
D. Only 3 and 4
E. None of them

3. The graph represents the straight-line motion of a car. How far does the car travel between t = 2 s and t =5s?

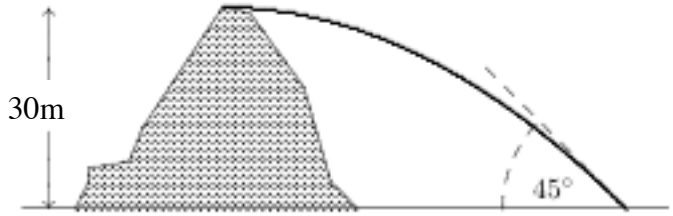


A. 4 m
B. 12 m
C. 24 m
D. 36 m
E. 60 m

4. An object rests on a horizontal frictionless surface. A horizontal force of magnitude F is applied. This force produces an acceleration:

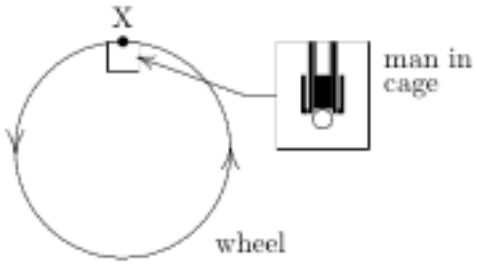
A. only if F is larger than the weight of the object
B. only while the object suddenly changes from rest to motion
C. always
D. only if the inertia of the object decreases
E. only if F is increasing

5. A ball is thrown horizontally from the top of a 30-m high hill. It strikes the ground at an angle of 45°. With what speed was it thrown?



A. 16 m/s
B. 24 m/s
C. 28 m/s
D. 30 m/s
E. 40 m/s

6. A giant wheel, having a diameter of 40 m, is fitted with a cage and platform on which a man of mass m stands. The wheel is rotated in a vertical plane at such a speed that the force exerted by the man on the platform is equal to his weight when the cage is at X, as shown. The net force on the man at point X is:

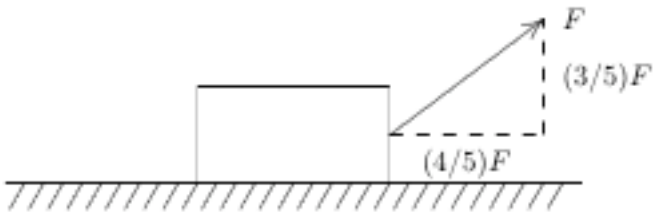


A. zero
B. mg, down
C. mg, up
D. 2mg, down
E. 2mg, up

7. A 13-N weight and a 12-N weight are connected by a massless string over a massless, frictionless pulley. The 13-N weight has a downward acceleration with magnitude equal to that of a freely falling body times:

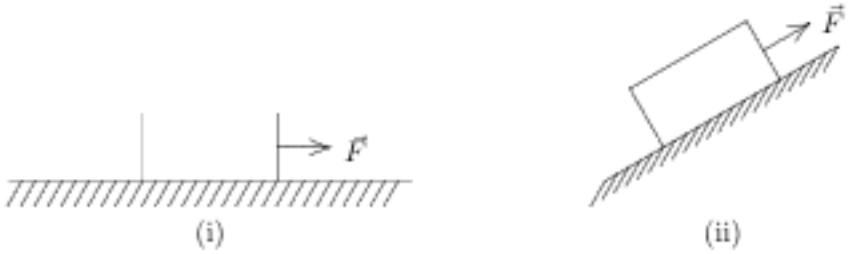
A. 1
B. 1/12
C. 1/13
D. 1/25
E. 13/25

8. A 400-N block is dragged along a rough horizontal surface with coefficient of kinetic friction μ_{kin}=0.4 by an applied force F as shown. The block moves at constant velocity. The magnitude of F is:



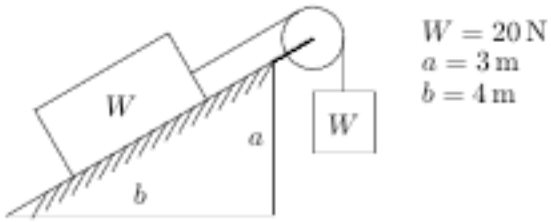
A. 100 N
B. 150 N
C. 200 N
D. 290 N
E. 400 N

9. A heavy wooden block is dragged by a force F along a rough steel plate, as shown below for two possible situations. The magnitude of F is the same for the two situations. The magnitude of the frictional force in (ii), as compared with that in (i) is:



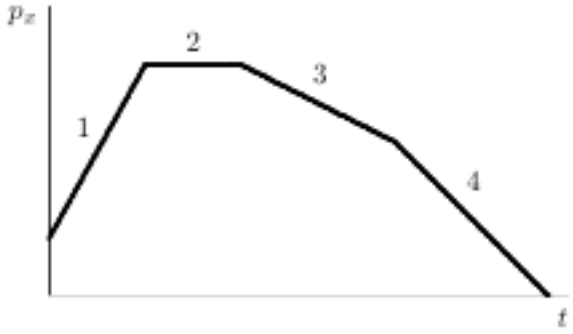
A. the same
B. greater
C. less
D. less for some angles and greater for others
E. can be less or greater, depending on the magnitude of the applied force.

10. The system shown remains at rest. Each block weighs 20 N. The force of friction on the upper block is:



A. 4 N
B. 8 N
C. 12 N
D. 16 N
E. 20 N

11. A particle moves along the x axis. Its momentum component is graphed below as a function of time. Rank the numbered regions according to the magnitude of the force acting on the particle, least to greatest.



A. 1, 2, 3, 4
B. 2, 3, 4, 1
C. 1, 4, 3, 2
D. 1, 3, 4, 2
E. 2, 4, 3, 1

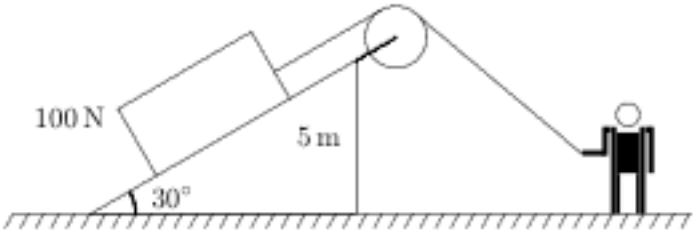
12. A 4.0-N puck is traveling at 3.0m/s. It strikes a 8.0-N puck, which is stationary. The two pucks stick together. Their common final speed is:

A. 1.0m/s
B. 1.5m/s
C. 2.0m/s
D. 2.3m/s
E. 3.0m/s

13. A man sits in the back of a canoe in still water. He then moves to the front of the canoe and sits there. Afterwards the canoe:

A. is forward of its original position and moving forward
B. is forward of its original position and moving backward
C. is rearward of its original position and moving forward
D. is rearward of its original position and moving backward
E. is rearward of its original position and not moving

14. A man pulls a 100-N crate up a frictionless 30° slope 5 m high, as shown. Assuming that the crate moves at constant speed, the work done by the man is:

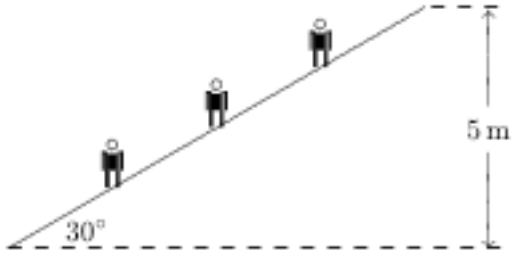


A. –500 J,
B. –250 J,
C. 0 J,
D. 250 J,
E. 500 J

15. Two trailers, X with mass 500 kg and Y with mass 2000 kg, are being pulled at the same speed. The ratio of the kinetic energy of Y to that of X is:

A. 1:1
B. 2:1
C. 4:1
D. 9:1
E. 1500:1

16. An escalator is used to move 20 people (60 kg each) per minute from the first floor of a department store to the second floor, 5 m above. Neglecting friction, the power required is approximately:



A. 100 W
B. 200 W
C. 1000 W
D. 2000 W
E. 60, 000 W

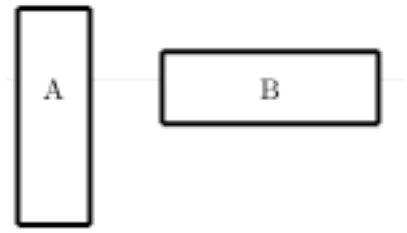
17. A 6.0-kg block is released from rest 80 m above the ground. When it has fallen 60 m its kinetic energy is approximately:

A. 4800 J
B. 3500 J
C. 1200 J
D. 120 J
E. 60 J

18. A 0.50-kg block attached to an ideal spring with a spring constant of 80 N/m oscillates on a horizontal frictionless surface. When the spring is 4.0 cm longer than its equilibrium length, the speed of the block is 0.50 m/s. The greatest speed of the block is:

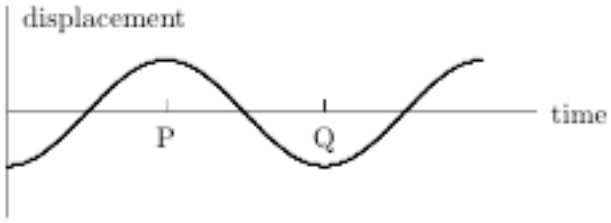
A. 0.23 m/s
B. 0.32 m/s
C. 0.55 m/s
D. 0.71 m/s
E. 0.93 m/s

19. Two identical blocks of ice float in water as shown. Then:



A. block A displaces a greater volume of water since the pressure acts on a smaller bottom area
B. block B displaces a greater volume of water since the pressure is less on its bottom
C. the two blocks displace equal volumes of water since they have the same weight
D. block A displaces a greater volume of water since its submerged end is lower in the water
E. block B displaces a greater volume of water since its submerged end has a greater area

20. In the diagram below, the interval PQ represents:



A. wavelength/2
B. wavelength
C. 2 x amplitude
D. period/2
E. period

21. Sinusoidal water waves are generated in a large ripple tank. The waves travel at 20 cm/s and their adjacent crests are 5.0 cm apart. The time required for each new whole cycle to be generated is:

A. 100 s
B. 4.0s
C. 2.0s
D. 0.5s
E. 0.25 s

22. A sinusoidal transverse wave is traveling on a string. Any point on the string:

A. moves in the same direction as the wave
B. moves in simple harmonic motion with a different frequency than that of the wave
C. moves in simple harmonic motion with the same angular frequency as the wave
D. moves in uniform circular motion with a different angular speed than the wave
E. moves in uniform circular motion with the same angular speed as the wave

23. Any point on a string carrying a sinusoidal wave is moving with its maximum speed when:

A. the magnitude of its acceleration is a maximum
B. the magnitude of its displacement is a maximum
C. the magnitude of its displacement is a minimum
D. the magnitude of its displacement is half the amplitude
E. the magnitude of its displacement is one-fourth the amplitude

24. A string carries a sinusoidal wave with an amplitude of 2.0 cm and a frequency of 100 Hz. The maximum speed of any point on the string is:

A. 2.0m/s
B. 4.0m/s
C. 6.3m/s
D. 13 m/s
E. unknown (not enough information is given)

25. Take the speed of sound to be 340 m/s. A thunder clap is heard about 3 s after the lightning is seen. The source of both light and sound is:

A. moving overhead faster than the speed of sound
B. emitting a much higher frequency than is heard
C. emitting a much lower frequency than is heard
D. about 1000 m away
E. much more than 1000 m away

26. “Beats” in sound refer to:

A. interference of two waves of the same frequency
B. combination of two waves of slightly different frequency
C. reversal of phase of reflected wave relative to incident wave
D. two media having slightly different sound velocities
E. effect of relative motion of source and observer

27. The sound intensity 5.0 m from a point source is 0.50 W/m . The power output of the source is:

A. 39 W
B. 160 W
C. 266 W
D. 320 W
E. 390 W

28. Fahrenheit and Kelvin scales agree at a reading of:

A. -40
B. 0
C. 273
D. 301
E. 574

29. An ideal gas occupies 12 liters at 293 K and 1 atm (76 cm Hg). Its temperature is now raised to 373 K and its pressure increased to 215 cm Hg. The new volume is:

A. 0.2 liters
B. 5.4 liters
C. 13.6 liters
D. 20.8 liters
E. none of these

30. Air is pumped into a bicycle tire at constant temperature. The pressure increases because:

A. more molecules strike the tire wall per second
B. the molecules are larger
C. the molecules are farther apart
D. each molecule is moving faster
E. each molecule has more kinetic energy

31. Rank, from smallest to largest, the changes in entropy of a pan of water on a hot plate, as the temperature of the water

1. goes from 20°C to 30°C
2. goes from 30°C to 40°C
3. goes from 40°C to 45°C
4. goes from 80°C to 85°C

A. 1, 2, 3, 4
B. 4, 3, 2, 1
C. 1 and 2 tie, then 3 and 4 tie
D. 3 and 4 tie, then 1 and 2 tie
E. 4, 3, 2, 1

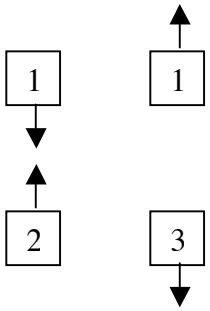
32. The magnitude of the charge on an electron is approximately:

A. 10^{23} C
B. 10^{-23} C
C. 10^{19} C
D. 10^{-19} C
E. 10^{9} C

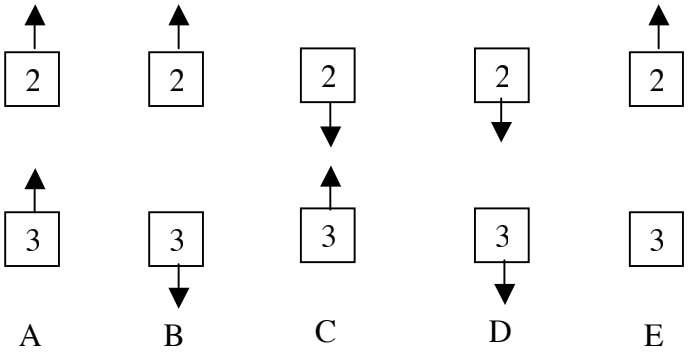
33. The charge on a glass rod that has been rubbed with silk is called positive:

A. by arbitrary convention
B. so that the proton charge will be positive
C. to conform to the conventions adopted for G and m in Newton's law of gravitation
D. because like charges repel
E. because glass is an insulator

34. The diagram shows two pairs of heavily charged plastic cubes. Cubes 1 and 2 attract each other and cubes 1 and 3 repel each other.



Which of the following illustrates the forces of 2 on 3 and 3 on 2?



35. The leaves of a positively charged electroscope diverge more when an object is brought near the knob of the electroscope. The object must be:

A. a conductor
B. an insulator
C. positively charged
D. negatively charged
E. uncharged

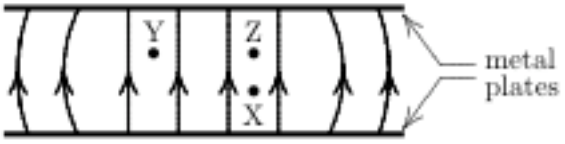
36. Two small charged objects attract each other with a force F when separated by a distance d. If the charge on each object is reduced to one-fourth of its original value and the distance between them is reduced to d/2 the force becomes:

A. F/16
B. F/8
C. F/4
D. F/2
E. F

37. Two identical charges, 2.0 m apart, exert forces of magnitude 4.0 N on each other. The value of either charge is:

A. 1.8×10^{-9} C
B. 2.5×10^{-5} C
C. 4.2×10^{-5} C
D. 1.9×10^{5} C
E. 3.8×10^{5} C

38. The diagram shows the electric field lines due to two charged parallel metal plates. We conclude that:

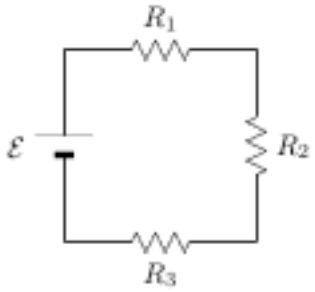


A. the upper plate is positive and the lower plate is negative
B. a proton at X would experience the same force if it were placed at Y
C. a proton at X experiences a greater force than if it were placed at Z
D. a proton at X experiences less force than if it were placed at Z
E. an electron at X could have its weight balanced by the electrical force

39. A 60-watt light bulb carries a current of 0.5 A. The total charge passing through it in one hour is:

A. 120 C
B. 3600 C
C. 3000 C
D. 2400 C
E. 1800 C

40. In the diagram $R_1 > R_2 > R_3$. Rank the three resistors according to the current in them, least to greatest.

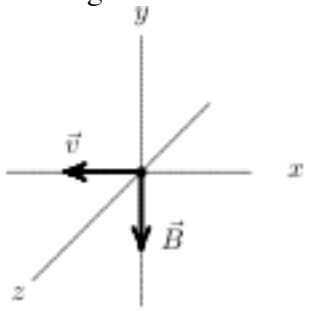


A. 1, 2, 3
B. 3, 2, 1
C. 1, 3, 2
D. 3, 1, 3
E. All are the same

41. Four 20-Ω resistors are connected in parallel and the combination is connected to a 20-V emf device. The current in the device is:

A. 0.25 A
B. 1.0 A
C. 4.0 A
D. 5.0 A
E. 100 A

42. An electron moves in the negative x direction, through a uniform magnetic field in the negative y direction. The magnetic force on the electron is:

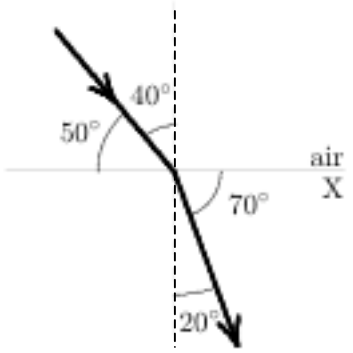


A. in the negative x direction
B. in the positive y direction
C. in the negative y direction
D. in the positive z direction
E. in the negative z direction

43. As used in the laws of reflection and refraction, the “normal” direction is:

A. any convenient direction
B. tangent to the interface
C. along the incident ray
D. perpendicular to the electric field vector of the light
E. perpendicular to the interface

44. The diagram shows the passage of a ray of light from air into a substance X. The index of refraction of X is:



A. 0.53
B. 0.88
C. 1.9
D. 2.2
E. 3.0

45. When you stand in front of a plane mirror, your image is:

A. real, erect, and smaller than you
B. real, erect, and the same size as you
C. virtual, erect, and smaller than you
D. virtual, erect, and the same size as you
E. real, inverted, and the same size as you

46. An object is 30 cm in front of a converging lens of focal length 10 cm. The image is:

A. real and larger than the object
B. real and the same size than the object
C. real and smaller than the object
D. virtual and the same size than the object
E. virtual and smaller than the object

47. In a Young's double-slit experiment the center of a bright fringe occurs wherever waves from the slits differ in the distance they travel by a multiple of:

A. a fourth of a wavelength
B. a half a wavelength
C. a wavelength
D. three-fourths of a wavelength
E. none of the above

48. A consequence of Einstein's theory of relativity is:

A. moving clocks run more slowly than when they are at rest
B. moving rods are longer than when they are at rest
C. light has both wave and particle properties
D. the laws of physics must appear the same to all observers moving with uniform velocity relative to each other
E. everything is relative

49. Light from a stationary spaceship is observed, then the spaceship moves directly away from the observer at high speed while still emitting the light. As a result, the light seen by the observer has:

A. a higher frequency and a longer wavelength than before
B. a lower frequency and a shorter wavelength than before
C. a higher frequency and a shorter wavelength than before
D. a lower frequency and a longer wavelength than before
E. the same frequency and wavelength as before

50. If the mass of a particle is zero its speed must be:

A. c
B. infinite
C. 0
D. any speed less than c
E. any speed greater than c