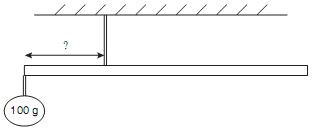
1. A 50 g meterstick is to be suspended by a single string. A 100 g ball hangs from the left-hand edge of the meterstick. Where should the string be attached so that the meterstick hangs in equilibrium?



(A) At the left-hand edge

(B) 40 cm from left-hand edge

(C) 30 cm from right-hand edge

(D) 17 cm from left-hand edge

(E) At the midpoint of the meterstick

2. In the diagram below, a 1.0 kg cart and a 2.0 kg cart are connected by a rope. The spring scale reads 10 N. What is the tension in the rope connecting the two carts? Neglect any friction.



(A) 30 N

(B) 10 N

(C) 6.7 N

(D) 5 N

(E) 3.3 N

3. Two identical balls have initial velocities = 4 m/s to the right and = 3 m/s to the left, respectively. The balls collide head on and stick together. What is the velocity of the combined balls after the collision?

(A) m/s to the right

(B) m/s to the right

(C) m/s to the right

(D) m/s to the right

(E) 1 m/s to the right

4. The front wheel on an ancient bicycle has radius 0.5 m. It moves with angular velocity given by the function *ω*(*t*) = 2+4*t*2, where *t* is in seconds. About how far does the bicycle move between *t* = 2 and *t* = 3 seconds?

(A) 36 m

(B) 27 m

(C) 21 m

(D) 14 m

(E) 7 m

5. A small heat engine operates using a pan of 100°C boiling water as the high temperature reservoir and the atmosphere as a low temperature reservoir. Assuming ideal behavior, how much more efficient is the engine on a cold, 0°C day than on a warm, 20°C day?

(A) 1.2 times as efficient

(B) 2 times as efficient

(C) 20 times as efficient

(D) Inﬁnitely more efficient

(E) Just as efficient

6. A projectile is launched on level ground in a parabolic path so that its range would normally be 500 m. When the projectile is at the peak of its ﬂight, the projectile breaks into two pieces of equal mass. One of these pieces falls straight down, with no further horizontal motion. How far away from the launch point does the other piece land?

(A) 250 m

(B) 375 m

(C) 500 m

(D) 750 m

(E) 100 m

7. 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

8. A drag racing car starts from rest at *t* = 0 and moves along a straight line with velocity given by *v* = *bt*2, where *b* is a constant. The expression for the distance traveled by this car from its position at *t* = 0 is:

(A) *bt*3

(B)

(C) 4*bt*2

(D) 3*bt*2

(E) 5*bt*2

9. A plane traveling north at 200 m/s turns and then travels south at 200 m/s. The change in its velocity is:

(A) 0

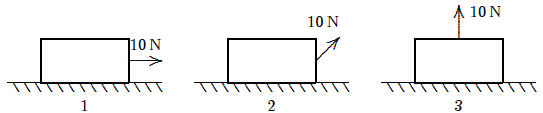
(B) 200 m/s north

(C) 200 m/s south

(D) 400 m/s north

(E) 400 m/s south

10. A crate rests on a horizontal surface and a woman pulls on it with a 10 N force. No matter what the orientation of the force, the crate does not move. Rank the situations shown below according to the magnitude of the frictional force of the surface on the crate, least to greatest.



(A) 1, 2, 3

(B) 2, 1, 3

(C) 2, 3, 1

(D) 1, 3, 2

(E) 3, 2, 1

11. A horizontal shove of at least 200 N is required to start moving a 800 N crate initially at rest on a horizontal floor. The coefficient of static friction is:

(A) 0.25

(B) 0.125

(C) 0.5

(D) 4

(E) 0.87

12. A 2 kg object is moving at 3 m/s. A 4 N force is applied in the direction of motion and then removed after the object has traveled an additional 5 m. The work done by this force is:

(A) 12 J

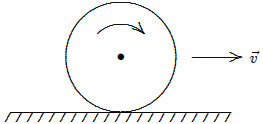
(B) 15 J

(C) 18 J

(D) 20 J

(E) 38 J

13. A wheel of radius 0.5 m rolls without sliding on a horizontal surface as shown. Starting from rest, the wheel moves with constant angular acceleration 6 rad/s2. The distance traveled by the center of the wheel from *t* = 0 to *t* = 3 s is:



(A) 0

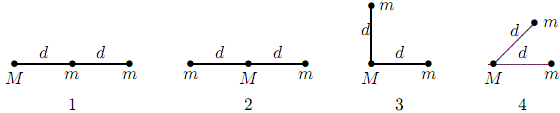
(B) 27 m

(C) 13.5 m

(D) 18 m

(E) 4 m

14. Three particles, two with mass *m* and one with mass *M*, might be arranged in any of the four conﬁgurations known below. Rank the conﬁgurations according to the magnitude of the gravitational force on *M*, least to greatest.



(A) 1, 2, 3, 4

(B) 2, 1, 3, 4

(C) 2, 1, 4, 3

(D) 2, 3, 4, 2

(E) 2, 3, 2, 4

15. A particle is in simple harmonic motion with period *T*. At time *t* = 0 it is at the equilibrium point. Of the following times, at which time is it furthest from the equilibrium point?

(A) 0.5*T*

(B) 0.7*T*

(C) *T*

(D) 1.4*T*

(E) 1.5*T*

16. Let *f* be the frequency, *v* the speed, and *T* the period of a sinusoidal traveling wave. The correct relationship is:

(A)

(B)

(C)

(D)

(E)

17. A ﬁre whistle emits a tone of 170 Hz. Take the speed of sound in air to be 340 m/s. The wavelength of this sound is about:

(A) 0.5 m

(B) 1 m

(C) 2 m

(D) 3

(E) 340 m

18. An automobile tire is pumped up to a gauge pressure of 2.0×105 Pa when the temperature is 27C. What is its gauge pressure after the car has been running on a hot day so that the tire temperature is 77C? Assume that the volume remains ﬁxed and take atmospheric pressure to be 1.013×105 Pa.

(A) 1.6×105 Pa

(B) 2.6×105 Pa

(C) 3.6×105 Pa

(D) 5.9×105 Pa

(E) 7.9×105 Pa

19. The total negative charge on the electrons in 1 mol of helium (atomic number 2, molar mass 4) is:

(A) 4.8×104 C

(B) 9.6×104 C

(C) 1.9×105 C

(D) 3.8×105 C

(E) 7.7×105 C

20. Two thin spherical shells, one with radius *R* and the other with radius 2*R*, surround an isolated charged point particle. The ratio of the number of ﬁeld lines through the larger sphere to the number through the smaller is:

(A) 1

(B) 2

(C) 4

(D) 0.5

(E) 0.25

21. A cylinder has a radius of 2.1 cm and a length of 8.8 cm. Total charge 6.1×10−7 C is distributed uniformly throughout. The volume charge density is:

(A) 5.3×10−5 C/m3

(B) 5.3×10−5 C/m2

(C) 8.5×10−4 C/m3

(D) 5×10−3 C/m3

(E) 6.3×10−2 C/m3

22. A particle with a charge of 5.5×10−8 C charge is ﬁxed at the origin. A particle with a charge of −2.3×10−8 C charge is moved from *x* =3.5 cm on the *x* axis to *y* = 3.5 cm on the *y* axis. The change in the potential energy of the two-particle system is:

(A) 3.2×10−4 J

(B) −3.2×10−4 J

(C) 9.3×10−3 J

(D) −9.3×10−3 J

(E) 0

23. If 500 J of work are required to carry a charged particle between two points with a potential diﬀerence of 20 V, the magnitude of the charge on the particle is:

(A) 0.04 C

(B) 12.5 C

(C) 24 C

(D) 13 C

(E) 15.8 C

24. 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

25. A proton (charge *e*), traveling perpendicular to a magnetic ﬁeld, experiences the same force as an alpha particle (charge 2*e*) which is also traveling perpendicular to the same ﬁeld. The ratio of their speeds, , is:

(A) 0.5

(B) 1

(C) 2

(D) 4

(E) 8

26. A uniform magnetic ﬁeld makes an angle of 30 with the *z* axis. If the magnetic ﬂux through a 1 m2 portion of the *xy* plane is 5 Wb then the magnetic ﬂux through a 2 m2 portion of the same plane is:

(A) 2.5 Wb

(B) 4.3 Wb

(C) 5 Wb

(D) 5.8 Wb

(E) 10 Wb

27. An *LC* circuit has an oscillation frequency of 105 Hz. If *C* = 0.1 µF, then *L* must be about:

(A) 10 mH

(B) 1 mH

(C) 25 µH

(D) 2.5 µH

(E) 1 pH

28. The number of possible values of the magnetic quantum number *ml* associated with a given value of the orbital quantum number *l* is:

(A) 1

(B) 2

(C) *l*

(D) 2*l*

(E) 2*l*+1

29. On the horizontal surface of a truck a block of mass 1 kg is placed (*µ* = 0.6) and truck is moving with acceleration 5 m/s2 then the frictional force on block will be :

(A) 5 N

(B) 6 N

(C) 5.88 N

(D) 8 N

(E) 12 N

30. The resistance of each arm of the wheat stone bridge is 10 ohm. A resistance of 10 ohm is connected in series with galvanometer then the equivalent resistance across the battery will be:

(A) 10 ohm

(B) 15 ohm

(C) 20 ohm

(D) 40 ohm

(E) 50 ohm