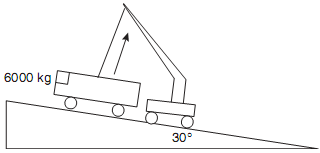
1. A 6000 kg bus sits on a 30° incline. A crane attempts to lift the bus off of the plane. The crane pulls perpendicular to the plane, as shown in the diagram. How much force must the crane apply so that the bus is suspended just above the surface? (cos30° = 0.87, sin30° = 0.5)



(A) 52000 N

(B) 30000 N

(C) 6000 N

(D) 5200 N

(E) 300 N

2. On a strange, airless planet, a ball is thrown downward from a height of 17 m. The ball initially travels at 15 m/s. If the ball hits the ground in 1 s, what is this planet’s gravitational acceleration?

(A) 2 m/s2

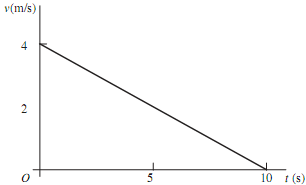
(B) 4 m/s2

(C) 6 m/s2

(D) 8 m/s2

(E) 10 m/s2

3. The velocity-time graph below represents the motion of a box. The only force applied to this box is a person pushing. Assuming that the box is moving to the right, what is the magnitude and direction of the force applied by the person pushing?



(A) 2 N, right

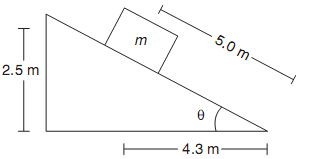
(B) 2 N, left

(C) 0.4 N, right

(D) 0.4 N, left

(E) 12.5 N, left

4. A block of weight *mg* = 100 N slides a distance of 5.0 m down a 30 degree incline, as shown below. If the block experiences a constant friction force of 10 N, how much work is done by the friction force?



(A) −43 J

(B) −25 J

(C) −500 J

(D) −100 J

(E) −50 J

5. A mass on a spring has a frequency of 2.5 Hz and an amplitude of 0.05 m. In one complete period, what distance does the mass traverse? (This question asks for the actual distance, not the displacement.)

(A) 0.05 cm

(B) 0.01 cm

(C) 20 cm

(D) 10 cm

(E) 5 cm

6. Brian saves 2 liter soda bottles so that he can construct a raft and ﬂoat out onto Haverford College’s Duck Pond. If Brian has a mass of 80 kg, what minimum number of bottles is necessary to support him? The density of water is 1000 kg/m3, and 1000 *L* = 1 m3.

(A) 1600 bottles

(B) 800 bottles

(C) 200 bottles

(D) 40 bottles

(E) 4 bottles

7. A particle moves along the *x* axis from *xi* to *xf*. Of the following values of the initial and final coordinates, which results in a negative displacement?

(A) *xi* = 4 m, *xf*= 6 m

(B) *xi* = -4 m, *xf*= -8 m

(C) *xi* = -4 m, *xf*= 2 m

(D) *xi* = -4 m, *xf*= -2 m

(E) *xi* = -4 m, *xf*= 4 m

8. A car starts from Astana, goes 50 km in a straight line to Burabay, immediately turns around, and returns to Astana. The time for this round trip is 2 hours. The average speed of the car for this round trip is:

(A) 0

(B) 50 km/hr

(C) 100 km/hr

(D) 200 km/hr

(E) 150 km/hr

9. A vector of magnitude 3 cannot be added to a vector of magnitude 4 so that the magnitude of the resultant is:

(A) 0

(B) 1

(C) 3

(D) 5

(E) 7

10. A forward horizontal force of 12 N is used to pull a 240 N crate at constant velocity across a horizontal floor. The coefficient of friction is:

(A) 0.5

(B) 0.05

(C) 2

(D) 0.2

(E) 20

11. A 40 N crate rests on a rough horizontal floor. A 12 N horizontal force is then applied to it. If the coefficients of friction are *μs* = 0.5 and *μk* = 0.4, the magnitude of the frictional force on the crate is:

(A) 8 N

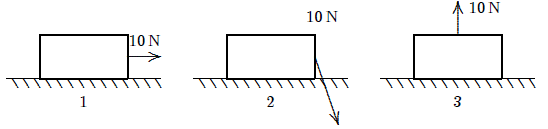
(B) 12 N

(C) 16 N

(D) 20 N

(E) 40 N

12. A crate moves 10 m to the right on a horizontal surface as a woman pulls on it with a 10 N force. Rank the situations shown below according to the work done by her force, least to greatest.



(A) 1, 2, 3

(B) 2, 1, 3

(C) 2, 3, 1

(D) 1, 3, 2

(E) 3, 2, 1

13. At the same instant that a 0.5 kg ball is dropped from 25 m above Earth, a second ball, with a mass of 0.25 kg, is thrown straight upward from Earth’s surface with an initial speed of 15 m/s.

They move along nearby lines and pass each other without colliding. At the end of 2 s the height above Earth’s surface of the center of mass of the two-ball system is:

(A) 2.9 m

(B) 4 m

(C) 5 m

(D) 7.1 m

(E) 11 m

14. The coefficient of static friction between a certain cylinder and a horizontal floor is 0.4. If the rotational inertia of the cylinder about its symmetry axis is given by *I* = 0.5*MR*2, then the magnitude of the maximum acceleration the cylinder can have without sliding is:

(A) 0.1*g*

(B) 0.2*g*

(C) 0.4*g*

(D) 0.8*g*

(E) *g*

15. Let *M* denote the mass of Earth and let *R* denote its radius. The ratio at Earth’s surface is:

(A)

(B)

(C)

(D)

(E)

16. A particle is in simple harmonic motion with period *T*. At time *t* = 0 it is halfway between the equilibrium point and an end point of its motion, traveling toward the end point. The next time it is at the same place is:

(A) *t* = *T*

(B) *t* = 2*T*

(C) *t* = 3*T*

(D) *t* = 4*T*

(E) None of the above

17. A wave is described by *y*(*x*, *t*) = 0.1sin(3*x*+10*t*), where *x* is in meters, *y* is in centimeters, and *t* is in seconds. The angular wave number is:

(A) 0.1 rad/m

(B) 3*π* rad/m

(C) 1 rad/cm

(D) 2 rad/cm

(E) 3 rad/cm

18. 273 cm3 of an ideal gas is at 0C. It is heated at constant pressure to 10C. It will now occupy:

(A) 263 cm3

(B) 273 cm3

(C) 283 cm3

(D) 278 cm3

(E) 293 cm3

19. Oxygen (molar mass = 32 g) occupies a volume of 12 liters when its temperature is 20C and its pressure is 1 atm. Using *R* = 0.082 literatm/molK, calculate the mass of the oxygen:

(A) 6.4 g

(B) 10 g

(C) 16 g

(D) 32 g

(E) 100 g

20. A wire carries a steady current of 2 A. The charge that passes a cross section in 2 s is:

(A) 3.2×10−19 C

(B) 6.4×10−19 C

(C) 1 C

(D) 2 C

(E) 4 C

21. Charge is placed on the surface of a 2.7 cm radius isolated conducting sphere. The surface charge density is uniform and has the value 6.9×10−6 C/m2. The total charge on the sphere is:

(A) 5.6×10−10 C

(B) 2.1×10−8 C

(C) 4.7×10−8 C

(D) 6.3×10−8 C

(E) 9.5×10−3 C

22. A particle with a charge of 5.5×10−8 C is 3.5 cm from a particle with a charge of −2.3×10−8 C. The potential energy of this two-particle system, relative to the potential energy at inﬁnite separation 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) −33×10−3 J

23. During a lightning discharge, 30 C of charge move through a potential diﬀerence of 108 V in 2×10−2 s. The energy released by this lightning bolt is:

(A) 1.5×1011 J

(B) 3.0×109 J

(C) 6.0×107 J

(D) 3.3×106 J

(E) 1500 J

24. Each plate of a capacitor stores a charge of magnitude 1 mC when a 100 V potential diﬀerence is applied. The capacitance is:

(A) 5 µF

(B) 10 µF

(C) 50 µF

(D) 100 µF

(E) 0

25. Four wires meet at a junction. The ﬁrst carries 4 A into the junction, the second carries 5 A out of the junction, and the third carries 2 A out of the junction. The fourth carries:

(A) 7 A out of the junction

(B) 7 A into the junction

(C) 3 A out of the junction

(D) 3 A into the junction

(E) 1 A into the junction

26. Suppose this page is perpendicular to a uniform magnetic ﬁeld and the magnetic ﬂux through it is 5 Wb. If the page is turned by 30 around an edge the ﬂux through it will be:

(A) 2.5 Wb

(B) 4.3 Wb

(C) 5 Wb

(D) 5.8 Wb

(E) 10 Wb

27. We desire to make an *LC* circuit that oscillates at 100 Hz using an inductance of 2.5 H. We also need a capacitance of:

(A) 1 F

(B) 1 mF

(C) 1 µF

(D) 100 µF

(E) 1 pF

28. The ground state energy of an electron in a one-dimensional trap with zero potential energy in the interior and inﬁnite potential energy at the walls is 2 eV. If the width of the well is doubled, the ground state energy will be:

(A) 0.5 eV

(B) 1 eV

(C) 2 eV

(D) 4 eV

(E) 8 eV

29. A certain metal has 5.3×1029 conduction electrons/m3 and an electrical resistivity of 1.9×10−9 Ω m. The average time between collisions of electrons with atoms in the metal is:

(A) 5.6×10−33 s

(B) 1.3×10−31 s

(C) 9.9×10−22 s

(D) 4.6×10−15 s

(E) 3.5×10−14 s

30. If specific resistance of a potentiometer wire is 10–7 Ωm and current flow through it is 0.1 A, cross-sectional area of wire is 10–6 m2 then potential gradient will be:

(A) 10–2 V/m

(B) 10–4 V/m

(C) 10–6 V/m

(D) 10–8 V/m

(E) 10–10 V/m