MULTIPLE CHOICE

1. A constant force of 12 N in the positive x direction acts on a 4.0-kg object as it moves from the origin to the point $\left(6\hat{\mathbf{i}} - 8\hat{\mathbf{j}}\right)$ m. How much work is done by the given force during this displacement?
   a. +60 J
   b. +84 J
   c. +72 J
   d. +48 J
   e. +57 J

   ANS: C PTS: 2 DIF: Average

2. A 5.0-kg object is pulled along a horizontal surface at a constant speed by a 15-N force acting 20° above the horizontal. How much work is done by this force as the object moves 6.0 m?
   a. 78 J
   b. 82 J
   c. 85 J
   d. 74 J
   e. 43 J

   ANS: C PTS: 2 DIF: Average

3. A 2.0-kg projectile moves from its initial position to a point that is displaced 20 m horizontally and 15 m above its initial position. How much work is done by the gravitational force on the projectile?
   a. +0.29 kJ
   b. −0.29 kJ
   c. +30 J
   d. −30 J
   e. −50 J

   ANS: B PTS: 2 DIF: Average

4. How much work is done by a person lifting a 2.0-kg object from the bottom of a well at a constant speed of 2.0 m/s for 5.0 s?
   a. 0.22 kJ
   b. 0.20 kJ
   c. 0.24 kJ
   d. 0.27 kJ
   e. 0.31 kJ

   ANS: B PTS: 2 DIF: Average

5. A 2.5-kg object falls vertically downward in a viscous medium at a constant speed of 2.5 m/s. How much work is done by the force the viscous medium exerts on the object as it falls 80 cm?
   a. +2.0 J
   b. +20 J
   c. −2.0 J
   d. −20 J
   e. +40 J

   ANS: D PTS: 2 DIF: Average

6. A 2.0-kg particle has an initial velocity of $\left(5\hat{\mathbf{i}} - 4\hat{\mathbf{j}}\right)$ m/s. Some time later, its velocity is $7\hat{\mathbf{i}} + 3\hat{\mathbf{j}}$ m/s. How much work was done by the resultant force during this time interval, assuming no energy is lost in the process?

a. 17 J
b. 49 J
c. 19 J
d. 53 J
e. 27 J

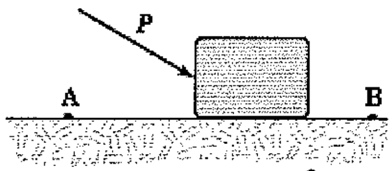
$W = \Delta KE = KE_f - KE_i = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

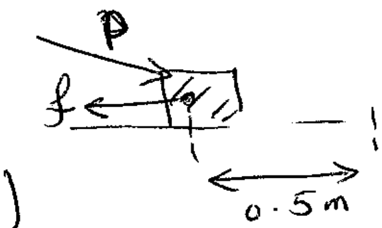
$v_f = \sqrt{7^2+3^2}$, $v_i = \sqrt{5^2+(-4)^2}$, $m = 2.0$ kg

$W = 17$ J.

ANS: A PTS: 2 DIF: Average

7. A block is pushed across a rough horizontal surface from point A to point B by a force (magnitude P = 5.4 N) as shown in the figure. The magnitude of the force of friction acting on the block between A and B is 1.2 N and points A and B are 0.5 m apart. If the kinetic energies of the block at A and B are 4.0 J and 5.6 J, respectively, how much work is done on the block by the force P between A and B?





$W = \Delta KE$

$W_P + W_f = \Delta KE$

$W_P - f(0.5) = 5.6 - 4$

$W_P = 5.6 - 4 + 1.2(0.5)$

$= 2.2$ J.

a. 2.7 J
b. 1.0 J
c. 2.2 J
d. 1.6 J
e. 3.2 J

ANS: C PTS: 2 DIF: Average

8. A constant force of 15 N in the negative y direction acts on a particle as it moves from the origin to the point $\left(3\hat{\mathbf{i}} + 3\hat{\mathbf{j}} - 1\hat{\mathbf{k}}\right)$ m. How much work is done by the given force during this displacement?

a. +45 J
b. −45 J
c. +30 J
d. −30 J
e. +75 J

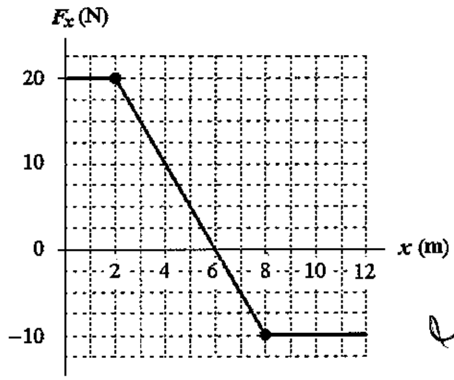
$\vec{F} = -15\hat{j}$

$W = \vec{F}\cdot\vec{d} = (3\hat{i} + 3\hat{j} - 1\hat{k})\cdot(-15\hat{j})$

$= -45$ J.

ANS: B PTS: 2 DIF: Average

9. An object moving along the x axis is acted upon by a force F_x that varies with position as shown. How much work is done by this force as the object moves from x = 2 m to x = 8 m?



$W = \sum$ Area under curves

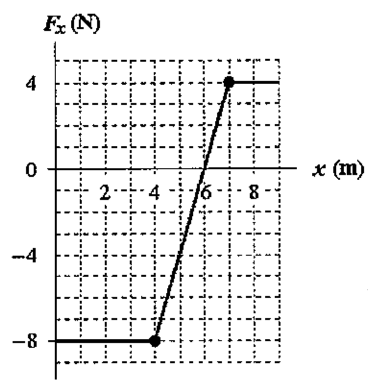
$W = 2(20) + \frac{1}{2}(4)(20) - \frac{1}{2}(2)(10) - 4(10)$

$= 30$ J

a. −10 J
b. +10 J
c. +30 J
d. −30 J
e. +40 J

ANS: C PTS: 2 DIF: Average

10. A body moving along the x axis is acted upon by a force F_x that varies with x as shown. How much work is done by this force as the object moves from $x = 1$ m to $x = 8$ m?



$W = \sum$ Area under curves

$W_{1\to 8} = -8(3) - \frac{1}{2}(2)(8) + \frac{1}{2}(1)(4) + 1(4)$

$= -24 - 8 + 2 + 4 = -26$ J

a. −2 J
b. −18 J
c. −10 J
d. −26 J
e. +18 J

ANS: D PTS: 2 DIF: Average

11. A force acting on an object moving along the x axis is given by $F_x = (14x - 3.0x^2)$ N where x is in m. How much work is done by this force as the object moves from $x = -1$ m to $x = +2$ m?

a. +12 J
b. +28 J
c. +40 J
d. +42 J
e. −28 J

$W = \int_{-1}^{2} F_x\,dx = \int_{-1}^{2} (14x - 3.0x^2)\,dx$

$W = 7x^2 - x^3 \Big|_{-1}^{2} = 28 - 7 - (8 + 1) = 28 - 7 - 8 - 1$ J

$= 12$ J

ANS: A PTS: 3 DIF: Challenging

12. The force an ideal spring exerts on an object is given by $F_x = -kx$, where x measures the displacement of the object from its equilibrium ($x = 0$) position. If $k = 60$ N/m, how much work is done by this force as the object moves from $x = -0.20$ m to $x = 0$?

$W = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$

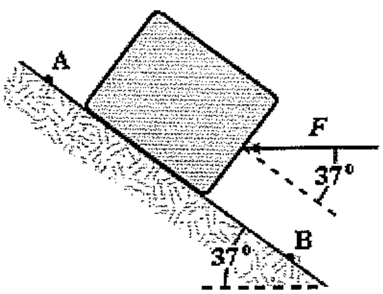
$W = \frac{1}{2}kx^2 = \frac{1}{2}(60)(0.2)^2$ J.

a. −1.2 J
b. +1.2 J
c. +2.4 J
d. −2.4 J
e. +3.6 J

ANS: B PTS: 2 DIF: Average

13. A 4.0-kg block is lowered down a 37° incline a distance of 5.0 m from point A to point B. A horizontal force (F = 10 N) is applied to the block between A and B as shown in the figure. The kinetic energy of the block at A is 10 J and at B it is 20 J. How much work is done on the block by the force of friction between A and B?

~~$mg\cos 37 - F\cos 37 - f = ma$~~



$W = \Delta KE = 20 - 10 = 10$ J.

$W = W_F + W_f + W_g = 10$ J

$(F\cos 37)\cdot\vec{d} + W_f + (mg\sin 37)\cdot\vec{d} = 10$ J

$-F\cos 37\,(5) + W_f + mg\sin 37\,(5) = 10$ J

$W_f = -68$ J

a. −58 J
b. −53 J
c. −68 J
d. −63 J
e. −47 J

ANS: C PTS: 3 DIF: Challenging

14. If the resultant force acting on a 2.0-kg object is equal to $(3\hat{\mathbf{i}} + 4\hat{\mathbf{j}})$ N, what is the change in kinetic energy as the object moves from $(7\hat{\mathbf{i}} - 8\hat{\mathbf{j}})$ m to $(11\hat{\mathbf{i}} - 5\hat{\mathbf{j}})$ m?

$W = \vec{F}\cdot\vec{d} = (3\hat{i} + 4\hat{j})\cdot(4\hat{i} + 3\hat{j})$

$= 12 + 12 = 24$ J

a. +36 J
b. +28 J
c. +32 J
d. +24 J
e. +60 J

ANS: D PTS: 2 DIF: Average

15. As a 2.0-kg object moves from $(2\hat{\mathbf{i}} + 5\hat{\mathbf{j}})$ m to $(6\hat{\mathbf{i}} - 2\hat{\mathbf{j}})$ m, the constant resultant force acting on it is equal to $(4\hat{\mathbf{i}} - 3\hat{\mathbf{j}})$ N. If the speed of the object at the initial position is 4.0 m/s, what is its kinetic energy at its final position?

$W = \vec{F}\cdot\vec{d} = (4\hat{i} - 3\hat{j})\cdot(4\hat{i} - 7\hat{j})$

$16 + 21 = KE_f - KE_i$

$\frac{1}{2}mv_f^2 \qquad \frac{1}{2}mv_i^2$

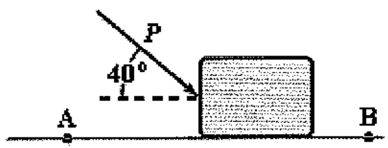
Solve for KE_f: $KE_f = 37 + \frac{1}{2}(2)(4)^2 = 53$ J

a. 62 J
b. 53 J
c. 73 J
d. 86 J

e. 24 J

ANS: B PTS: 3 DIF: Challenging

16. A block slides on a rough horizontal surface from point A to point B. A force (magnitude $P = 2.0$ N) acts on the block between A and B, as shown. Points A and B are 1.5 m apart. If the kinetic energies of the block at A and B are 5.0 J and 4.0 J, respectively, how much work is done on the block by the force of friction as the block moves from A to B?



$\sum W = W_f + W_P = \Delta K = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 = 4 - 5 = -1$ J.

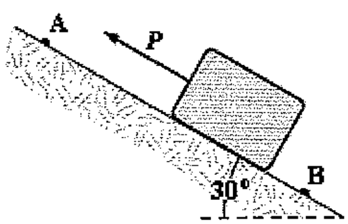
$W_f + P\cos 40 (1.5) = -1$

$W_f = -1 - P\cos 40 (1.5) = -3.29$ J

a. −3.3 J
b. +1.3 J
c. +3.3 J
d. −1.3 J
e. +4.6 J

ANS: A PTS: 2 DIF: Average

17. A 2.0-kg block slides down a frictionless incline from point A to point B. A force (magnitude $P = 3.0$ N) acts on the block between A and B, as shown. Points A and B are 2.0 m apart. If the kinetic energy of the block at A is 10 J, what is the kinetic energy of the block at B?



$\sum W = \Delta K = K_B - K_A$

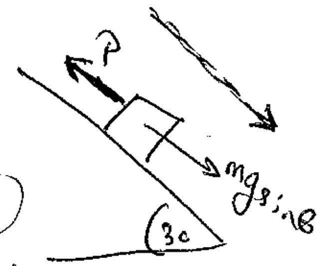
$W_P + W_g = K_B - K_A$

$K_B = W_P + W_g + K_A$

$= (3)(2)\cos 180 + mg\sin\theta (2) + 10$ (Cos 0)

$= -6 + 2(9.8)\sin(30)(2) + 10$

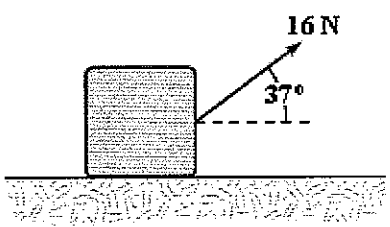
$= 23.6$ J



a. 27 J
b. 20 J
c. 24 J
d. 17 J
e. 37 J

ANS: C PTS: 2 DIF: Average

18. A 3.0-kg block is dragged over a rough horizontal surface by a constant force of 16 N acting at an angle of 37° above the horizontal as shown. The speed of the block increases from 4.0 m/s to 6.0 m/s in a displacement of 5.0 m. What work was done by the friction force during this displacement?



$\sum W = \Delta K$

$W_F + W_f = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$W_F + W_f = \frac{1}{2}(3)(36 - 16)$

a. −34 J

$W_f = 30 - W_F = 30 - 16\cos 37 (5) = -33.89$ J

b. −64 J
c. −30 J
d. −94 J
e. +64 J

ANS: A PTS: 2 DIF: Average

19. A 10-kg block on a horizontal frictionless surface is attached to a light spring (force constant = 0.80 kN/m). The block is initially at rest at its equilibrium position when a force (magnitude P = 80 N) acting parallel to the surface is applied to the block, as shown. What is the speed of the block when it is 13 cm from its equilibrium position?

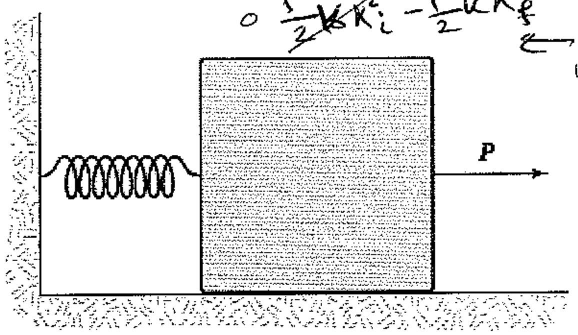
$\sum W = \Delta K$

$W_{spring} + W_P = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$-\frac{1}{2}kx^2 + P(13\times10^{-2}) = \frac{1}{2}(10)v_f^2$

$-\frac{1}{2}(0.8\times10^3)(13\times10^{-2})^2 + 80(13\times10^{-2}) = \frac{1}{2}(10)v_f^2$

$v_f = 0.85$ m/s



a. 0.85 m/s
b. 0.89 m/s
c. 0.77 m/s
d. 0.64 m/s
e. 0.52 m/s

ANS: A PTS: 2 DIF: Average

20. A 10-kg block on a horizontal frictionless surface is attached to a light spring (force constant = 1.2 kN/m). The block is initially at rest at its equilibrium position when a force (magnitude P) acting parallel to the surface is applied to the block, as shown. When the block is 8.0 cm from the equilibrium position, it has a speed of 0.80 m/s. How much work is done on the block by the force P as the block moves the 8.0 cm?

$\sum W = \Delta K$

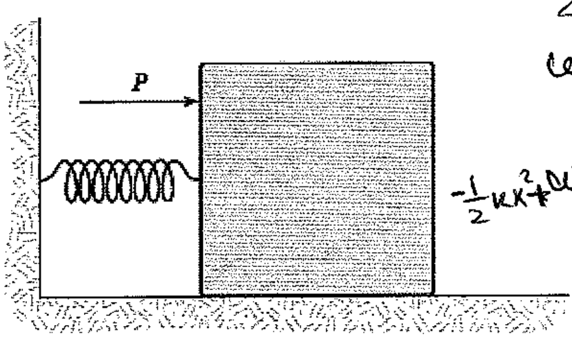
$W_s + W_P = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$-\frac{1}{2}kx^2 + W_P = \frac{1}{2}mv_f^2$

$W_P = \frac{1}{2}mv_f^2 + \frac{1}{2}kx^2$

$= \frac{1}{2}(10)(0.8)^2 + \frac{1}{2}(1.2\times10^3)(8\times10^{-2})^2$

$= 7.04$ J



a. 8.3 J
b. 6.4 J
c. 7.0 J
d. 7.7 J
e. 3.9 J

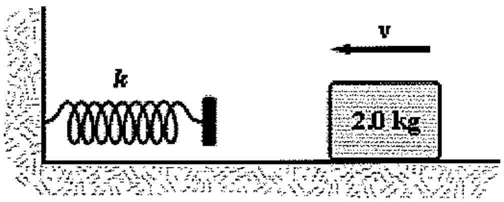
ANS: C PTS: 2 DIF: Average

21. A 20-kg block on a horizontal surface is attached to a light spring (force constant = 8.0 kN/m). The block is pulled 10 cm to the right from its equilibrium position and released from rest. When the block has moved 2.0 cm toward its equilibrium position, its kinetic energy is 13 J. How much work is done by the frictional force on the block as it moves the 2.0 cm?

a. −2.5 J
b. −1.4 J
c. −3.0 J
d. −1.9 J
e. −14 J

ANS: B PTS: 2 DIF: Average

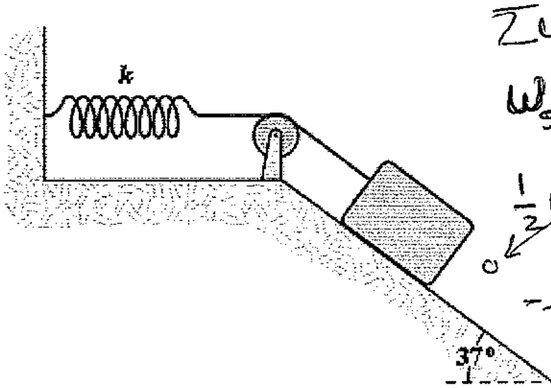
22. The horizontal surface on which the block slides is frictionless. The speed of the block before it touches the spring is 6.0 m/s. How fast is the block moving at the instant the spring has been compressed 15 cm? $k = 2.0$ kN/m



a. 3.7 m/s
b. 4.4 m/s
c. 4.9 m/s
d. 5.4 m/s
e. 14 m/s

ANS: A PTS: 2 DIF: Average

23. A 2.0-kg block situated on a frictionless incline is connected to a light spring ($k = 100$ N/m), as shown. The block is released from rest when the spring is unstretched. The pulley is frictionless and has negligible mass. What is the speed of the block when it has moved 0.20 m down the plane?



a. 76 cm/s
b. 68 cm/s
c. 60 cm/s
d. 82 cm/s
e. 57 cm/s

ANS: C PTS: 2 DIF: Average

24. A 2.0-kg block sliding on a frictionless horizontal surface is attached to one end of a horizontal spring ($k = 600$ N/m) which has its other end fixed. The speed of the block when the spring is extended 20 cm is equal to 3.0 m/s. What is the maximum speed of this block as it oscillates?
    a. 4.6 m/s
    b. 5.3 m/s
    c. 5.7 m/s
    d. 4.9 m/s
    e. 3.5 m/s

ANS: A PTS: 2 DIF: Average

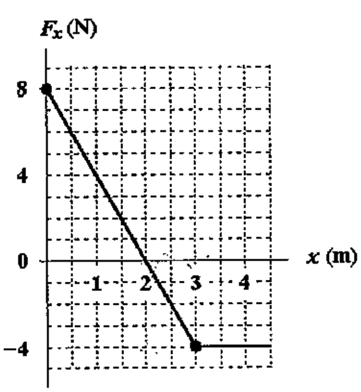
25. A 10-kg block on a rough horizontal surface is attached to a light spring (force constant = 1.4 kN/m). The block is pulled 8.0 cm to the right from its equilibrium position and released from rest. The frictional force between the block and surface has a magnitude of 30 N. What is the kinetic energy of the block as it passes through its equilibrium position?
    a. 4.5 J
    b. 2.1 J
    c. 6.9 J
    d. 6.6 J
    e. 4.9 J

ANS: B PTS: 2 DIF: Average

26. A 2.0-kg body moving along the x axis has a velocity $v_x = 5.0$ m/s at $x = 0$. The only force acting on the object is given by $F_x = (-4.0x)$ N, where x is in m. For what value of x will this object first come (momentarily) to rest?
    a. 4.2 m
    b. 3.5 m
    c. 5.3 m
    d. 6.4 m
    e. 5.0 m

ANS: B PTS: 2 DIF: Average

27. A 1.5-kg object moving along the x axis has a velocity of +4.0 m/s at $x = 0$. If the only force acting on this object is shown in the figure, what is the kinetic energy of the object at $x = +3.0$ m?

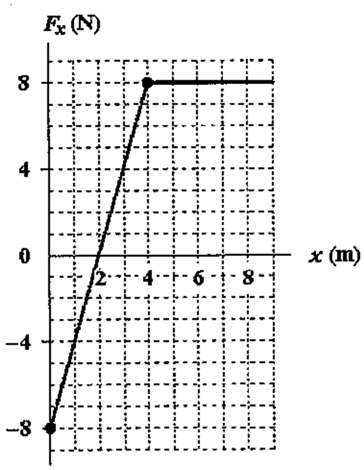


    a. 18 J
    b. 21 J
    c. 23 J

d. 26 J
e. 8 J

ANS: A PTS: 2 DIF: Average

28. The only force acting on a 1.6-kg body as it moves along the x axis is given in the figure. If the velocity of the body at $x = 2.0$ m is 5.0 m/s, what is its kinetic energy at $x = 5.0$ m?



$(K)_{x=2} + \frac{16}{2} + 8(1) = (K)_{x=5}$

$\frac{1}{2}(1.6)25 + 8 + 8 = (K)_{x=5}$

$36\,J = (K)_{x=5}$

a. 52 J
b. 44 J
c. 36 J
d. 60 J
e. 25 J

ANS: C PTS: 2 DIF: Average

29. The only force acting on a 2.0-kg body moving along the x axis is given by $F_x = (2.0x)$ N, where x is in m. If the velocity of the object at $x = 0$ is +3.0 m/s, how fast is it moving at $x = 2.0$ m?

a. 4.2 m/s
b. 3.6 m/s
c. 5.0 m/s
d. 5.8 m/s
e. 2.8 m/s

$W = \int F_x\,dx = \int_0^2 2.0x\,dx = x^2\Big|_0^2 = 4\,J$

$= \Delta KE = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 \rightarrow \frac{1}{2}mv_f^2 = 4 + \frac{1}{2}mv_i^2$

$v_f^2 = 4 + 9 = 13\ m^2/s^2$

ANS: B PTS: 2 DIF: Average

30. The only force acting on a 2.0-kg body as it moves along the x axis is given by $F_x = (12 - 2.0x)$ N, where x is in m. The velocity of the body at $x = 2.0$ m is $5.5\hat{\mathbf{i}}$ m/s. What is the maximum kinetic energy attained by the body while moving in the $+x$ direction?

a. 36 J
b. 39 J
c. 43 J
d. 46 J
e. 30 J

$W = \Delta K$; $F_x = 12 - 2x$, $F_x = 0 = 12 - 2x$; $x = 6\,m$

$\int_2^6 (12 - 2x)\,dx = K_{2\to 6}$; $12x - x^2\Big|_2^6 = K_{2\to 6}$, $K_{2\to 6} = 16\,J$

$K = K_{0\to 2} + K_{2\to 6} = \frac{1}{2}(2)(5.5)^2 + 16 = 46.25\,J$

ANS: D PTS: 2 DIF: Average

31. The only force acting on a 1.8-kg body as it moves along the x axis is given by $F_x = -(3.0x)$ N, where x is in m. If the velocity of the body at $x = 0$ is $v_x = +8.0$ m/s, at what value of x will the body have a velocity of +4.0 m/s?

$W = K_f - K_i$; $W = \frac{1}{2}(1.8)(16 - 64) = -43.2\,J$

$W = \int_0^x F_x\,dx = \int_0^x -3x\,dx = \frac{-3x^2}{2}\Big|_0^x = \frac{-3x^2}{2} = -43.2$

$x = 5.36\,m$

a. 5.7 m
b. 5.4 m
c. 4.8 m
d. 4.1 m
e. 6.6 m

ANS: B PTS: 3 DIF: Challenging

32. Two vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$ are given by $\vec{\mathbf{A}} = 5\hat{\mathbf{i}} + 6\hat{\mathbf{j}} + 7\hat{\mathbf{k}}$ and $\vec{\mathbf{B}} = 3\hat{\mathbf{i}} - 8\hat{\mathbf{j}} + 2\hat{\mathbf{k}}$. If these two vectors are drawn starting at the same point, what is the angle between them?

a. 106°
b. 102°
c. 110°
d. 113°
e. 97°

$\vec{A}\cdot\vec{B} = AB\cos\theta$

$(5\hat{i}+6\hat{j}+7\hat{k})\cdot(3\hat{i}-8\hat{j}+2\hat{k}) = \sqrt{(5)^2+(6)^2+(7)^2}\sqrt{(3)^2+(-8)^2+(2)^2}\cos\theta$

$\cos\theta = 15-48+14/\sqrt{\ }\sqrt{\ }$, $\theta = \cos^{-1}(\quad)$

ANS: B PTS: 2 DIF: Average

33. If $\vec{\mathbf{A}} = 7\hat{\mathbf{i}} - 6\hat{\mathbf{j}} + 5\hat{\mathbf{k}}$, $|\vec{\mathbf{B}}| = 7$, and the angle between $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$ (when the two are drawn starting from the same point) is 60°, what is the scalar product of these two vectors?

a. −13
b. +13
c. +37
d. −37
e. 73

$\vec{A}\cdot\vec{B} = \sqrt{49+36+25}\,(7)\cos 60$

ANS: C PTS: 2 DIF: Average

34. If vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$ have magnitudes 12 and 15, respectively, and the angle between the two when they are drawn starting from the same point is 110°, what is the scalar product of these two vectors?

a. −76
b. −62
c. −90
d. −47
e. −170

$\vec{A}\cdot\vec{B} = (12)(15)\cos 110^\circ$

$= -61.56$

ANS: B PTS: 2 DIF: Average

35. If the vectors $\vec{\mathbf{A}}$ and $\vec{\mathbf{B}}$ have magnitudes of 10 and 11, respectively, and the scalar product of these two vectors is −100, what is the magnitude of the sum of these two vectors?

a. 6.6
b. 4.6
c. 8.3
d. 9.8
e. 7.6

$\vec{A}\cdot\vec{B} = AB\cos\theta = (10)(11)\cos\theta = -100$, $\theta = \cos^{-1}\left(\frac{-100}{110}\right)$

$\theta = 155.4^\circ$

$C = \sqrt{A^2+B^2+2AB\cos\theta} = 4.57$

ANS: B PTS: 2 DIF: Average

36. If the scalar product of two vectors, $\vec{\mathbf{A}}$ and $\vec{\mathbf{C}}$, is equal to −3.5, if $|\vec{\mathbf{A}}| = 2.0$, and the angle between the two vectors when they are drawn starting from the same point is equal to 130°, what is the magnitude of $\vec{\mathbf{C}}$?

a. 2.1

$\vec{A}\cdot\vec{C} = AC\cos\theta$

$-3.5 = 2\,C\cos(130)$

$C = \frac{-3.5}{2\cos(130)} = 2.72$

b. 2.5
c. 2.3
(d.) 2.7
e. 3.1

ANS: D PTS: 2 DIF: Average

37. If $\vec{A} \cdot \vec{C} = -7.5$, $\vec{A} = 3\hat{i} - 4\hat{j}$, and $|\vec{C}| = 6.5$, what is the angle between the two vectors when they are drawn starting from the same point?

$\vec{A} \cdot \vec{C} = AC\cos\theta$

a. 118°
b. 107°
c. 112°
(d.) 103°
e. 77°

$A = \sqrt{3^2 + (-4)^2} = 5$

then $-7.5 = 5(6.5)\cos\theta$

$\theta = \cos^{-1}\left(\frac{-7.5}{5(6.5)}\right) = 103.3°$

ANS: D PTS: 2 DIF: Average

38. Two vectors $\vec{A}$ and $\vec{B}$ are given by $\vec{A} = 4\hat{i} + 8\hat{j}$ and $\vec{B} = 6\hat{i} - 2\hat{j}$. The scalar product of $\vec{A}$ and a third vector $\vec{C}$ is −16. The scalar product of $\vec{B}$ and $\vec{C}$ is +18. The *z* component of $\vec{C}$ is 0. What is the magnitude of $\vec{C}$?

$\vec{A} \cdot \vec{C} = 4C_x + 8C_y = -16 \rightarrow (1)$

$\vec{B} \cdot \vec{C} = 6C_x - 2C_y = +18 \rightarrow (2)$

$4 \times (2) + (1)$: $4C_x + 24C_x = -16 + 18(4)$; $C_x = 2$

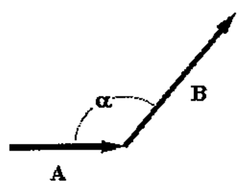
from (1) $C_y = -3$

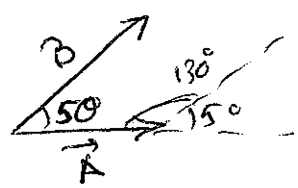
$C = \sqrt{C_x^2 + C_y^2} = 3.6$

a. 7.8
b. 6.4
(c.) 3.6
d. 5.0
e. 4.8

ANS: C PTS: 2 DIF: Average

39. If $\vec{A} = 10$, $\vec{B} = 15$, and $\alpha = 130°$, determine the scalar product of the two vectors shown.



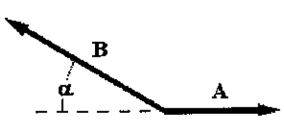


(a.) +96
b. −96
c. +51
d. −51
e. −35

$\vec{A} \cdot \vec{B} = AB\cos 50$
$= 10(15)\cos 50$
$= 96.4$

ANS: A PTS: 2 DIF: Average

40. If $\vec{A} = 5.0$, $\vec{B} = 8.0$, and $\alpha = 30°$, determine the scalar product of the two vectors shown.



$\vec{A} \cdot \vec{B} = (5)(8)\cos 150$

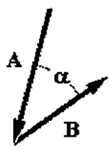
$= -34.64$

(a.) −35
b. +35

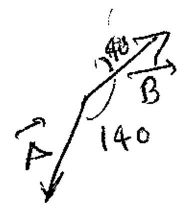
c. −20
d. +20
e. +40

ANS: A PTS: 2 DIF: Average

41. If $|\vec{\mathbf{A}}| = 6.0$, $|\vec{\mathbf{B}}| = 5.0$, and $\alpha = 40°$, determine the scalar product of the two vectors shown.



$\vec{A} \cdot \vec{B} = (6)(5)\cos(140)$
$= -22.98$



a. +19
b. +23
c. −19
d. −23
e. +30

ANS: D PTS: 2 DIF: Average

42. The same constant force is used to accelerate two carts of the same mass, initially at rest, on horizontal frictionless tracks. The force is applied to cart A for twice as long a time as it is applied to cart B. The work the force does on A is W_A; that on B is W_B. Which statement is correct?
a. $W_A = W_B$.
b. $W_A = \sqrt{2} W_B$.
c. $W_A = 2 W_B$.
d. $W_A = 4 W_B$.
e. $W_B = 2 W_A$.

ANS: D PTS: 1 DIF: Easy

43. Carts A and B have equal masses and travel equal distances on straight frictionless tracks while a constant force F is applied to A, and a constant force 2F is applied to B. The relative amounts of work done by the two forces are related by
a. $W_A = 4 W_B$.
b. $W_A = 2 W_B$.
c. $W_A = W_B$.
d. $W_B = 2 W_A$.
e. $W_B = 4 W_A$.

ANS: D PTS: 1 DIF: Easy

44. Carts A and B have equal masses and travel equal distances D on side-by-side straight frictionless tracks while a constant force F acts on A and a constant force 2F acts on B. Both carts start from rest. The velocities $\vec{\mathbf{v}}_A$ and $\vec{\mathbf{v}}_B$ of the bodies at the end of distance D are related by
a. $\vec{\mathbf{v}}_B = \vec{\mathbf{v}}_A$.
b. $\vec{\mathbf{v}}_B = \sqrt{2}\,\vec{\mathbf{v}}_A$.
c. $\vec{\mathbf{v}}_B = 2\,\vec{\mathbf{v}}_A$.
d. $\vec{\mathbf{v}}_B = 4\,\vec{\mathbf{v}}_A$.
e. $\vec{\mathbf{v}}_A = 2\,\vec{\mathbf{v}}_B$.

ANS: B PTS: 1 DIF: Easy

45. When a ball rises vertically to a height h and returns to its original point of projection, the work done by the gravitational force is

a. 0.
b. $-mgh$.
c. $+mgh$.
d. $-2mgh$.
e. $+2mgh$.

$W = -\Delta U = \Delta KE = 0$

ANS: A PTS: 1 DIF: Easy

46. When a crate of mass m is dragged a distance d along a surface with coefficient of kinetic friction μ_k, then dragged back along the same path to its original position, the work done by friction is

a. 0.
b. $-\mu_k mgd$.
c. $+\mu_k mgd$.
d. $-2\mu_k mgd$.
e. $+2\mu_k mgd$.

$f_k = \mu_k N$, $N = mg$, $W = -\mu_k mg - \mu_k mg = -2\mu_k mg$

ANS: D PTS: 1 DIF: Easy

47. Two balls, A and B, of mass m and 2m respectively, are carried to height h at constant velocity, but B rises twice as fast as A. The work the gravitational force does on B is

a. one quarter the work done on A.
b. one half the work done on A.
c. the same as the work done on A.
d. twice the work done on A.
e. four times the work done on A.

$W = -\Delta U = \Delta KE$
$W_a = mgh$, $W_b = 2mgh$

ANS: D PTS: 1 DIF: Easy

48. Equal amounts of work are performed on two bodies, A and B, initially at rest, and of masses M and $2M$ respectively. The relation between their speeds immediately after the work has been done on them is

a. $v_A = \sqrt{2}v_B$.
b. $v_A = 2v_B$.
c. $v_A = v_B$.
d. $v_B = \sqrt{2}v_A$.
e. $v_B = 2v_A$.

$W = \Delta KE = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
$W_M = \frac{1}{2}Mv_{fM}^2$, $W_{2M} = \frac{1}{2}2Mv_{2M}^2$
$W_M = W_{2M}$ $\frac{1}{2}Mv_{fM}^2 = Mv_{2M}^2 \rightarrow v_{fM} = \sqrt{2}\, v_{f2M}$

ANS: A PTS: 1 DIF: Easy

49. Two cannonballs are dropped from a second floor physics lab at height h above the ground. Ball B has four times the mass of ball A. When the balls pass the bottom of a first floor window at height $\frac{h}{4}$ above the ground, the relation between their kinetic energies, K_A and K_B, is

a. $K_A = 4K_B$.
b. $K_A = 2K_B$.
c. $K_A = K_B$.
d. $K_B = 2K_A$.
e. $K_B = 4K_A$.

$m_B = 4m_A$, $-\Delta U = \Delta KE \rightarrow \Delta KE + \Delta U = 0$
$KE_f + U_f = KE_i + U_i \rightarrow$ A: $KE_f + mg\frac{h}{4} = 0 + mgh$
$KE_f = \frac{3}{4}mgh$
B: $KE_f + 4mg\frac{h}{4} = 0 + 4mgh$
$KE_f = 3mgh$

ANS: E PTS: 1 DIF: Easy

then $(KE_f)_A = \frac{(KE_f)_B}{4}$

50. Two clowns are launched from the same spring-loaded circus cannon with the spring compressed the same distance each time. Clown A has a 40-kg mass; clown B a 60-kg mass. The relation between their kinetic energies at the instant of launch is

a. $K_A = \frac{3}{2}K_B$.

b. $K_A = \sqrt{\frac{3}{2}}K_B$.

c. $K_A = K_B$.

d. $K_B = \sqrt{\frac{3}{2}}K_A$.

e. $K_B = \frac{3}{2}K_A$.

ANS: C PTS: 1 DIF: Easy

51. Two clowns are launched from the same spring-loaded circus cannon with the spring compressed the same distance each time. Clown A has a 40-kg mass; clown B a 60-kg mass. The relation between their speeds at the instant of launch is

a. $v_A = \frac{3}{2}v_B$.

b. $v_A = \sqrt{\frac{3}{2}}v_B$.

c. $v_A = v_B$.

d. $v_B = \sqrt{\frac{3}{2}}v_A$.

e. $v_B = \frac{3}{2}v_A$.

ANS: B PTS: 1 DIF: Easy

52. In a contest, two tractors pull two identical blocks of stone the same distance over identical surfaces. However, block A is moving twice as fast as block B when it crosses the finish line. Which statement is correct?

a. Block A has twice as much kinetic energy as block B.
b. Block B has lost twice as much kinetic energy to friction as block A.
c. Block B has lost twice as much kinetic energy as block A.
d. Both blocks have had equal losses of energy to friction.
e. No energy is lost to friction because the ground has no displacement.

ANS: D PTS: 1 DIF: Easy

53. If the scalar (dot) product of two vectors is negative, it means that

a. there was a calculator error.
b. the angle between the vectors is less than 90 degrees.
c. the angle between the vectors is 90 degrees.
d. the angle between the vectors is greater than 270 degrees.
e. the angle between the vectors is between 90 and 180 degrees.

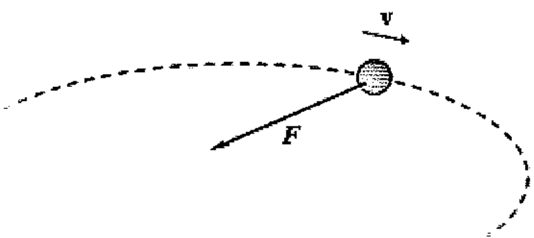
ANS: E PTS: 1 DIF: Easy

54. Two eggs of equal mass are thrown at a blanket with equal velocity. Egg B hits the blanket but egg A hits the wall instead. Compare the work done on the eggs in reducing their velocities to zero.

a. More work was done on A than on B.
b. More work was done on B than on A.
c. The amount of work is the same for both.
d. It is meaningless to compare the amount of work because the forces were so different.
e. Work was done on B, but no work was done on A because the wall did not move.

ANS: C PTS: 1 DIF: Easy

55. Planets go around the sun in elliptical orbits. The highly exaggerated diagram below shows a portion of such an orbit and the force on the planet at one position along that orbit. The planet is moving to the right. $F_{\parallel}$ and $F_{\perp}$ are the components of the force parallel (tangential) and perpendicular (normal) to the orbit. The work they do is $W_{\parallel}$ and $W_{\perp}$. At the position shown



a. $W_{\parallel}$ slows the planet down; $W_{\perp}$ speeds it up.
b. $W_{\parallel}$ slows the planet down; $W_{\perp}$ does no work on it.
c. $W_{\parallel}$ speeds the planet up; $W_{\perp}$ does no work on it.
d. $W_{\parallel}$ speeds the planet up; $W_{\perp}$ slows it down.
e. $W_{\parallel}$ does no work on it; $W_{\perp}$ speeds the planet up.

ANS: B PTS: 2 DIF: Average

56. A mass attached to the end of a spring is pulled out and released on a surface with friction. The work $\vec{F}_{sp} \cdot d\vec{x}$ done on the mass by the force exerted by the spring
a. never has the same sign as the change in energy owing to friction.
b. always has the same sign as the change in energy owing to friction.
c. has the same sign as the change in energy owing to friction during one half of each cycle.
d. never has the same sign as the change in energy owing to friction if the force of friction is greater than the spring force.
e. always has the same sign as the change in energy owing to friction if the force of friction is greater than the spring force.

ANS: C PTS: 2 DIF: Average

57. The work $\vec{F}_{sp} \cdot d\vec{x}$ done by the force exerted by the spring on a mass attached to the end of the spring when the mass has displacement $d\vec{x}$ is
a. always negative.
b. always positive.
c. negative half the time, positive the other half of the time.
d. positive more than it is negative.
e. negative more than it is positive.

ANS: C PTS: 1 DIF: Easy

58. A 30-kg child sitting 5.0 m from the center of a merry-go-round has a constant speed of 5.0 m/s. While she remains seated in the same spot and travels in a circle, the work the seat performs on her in one complete rotation is

a. 0 J.
b. 150 J.
c. 1 500 J.
d. 4 700 J.
e. 46 000 J.

ANS: A PTS: 1 DIF: Easy

59. Sally, who weighs 450 N, stands on a skate board while Roger pushes it forward 13.0 m at constant velocity on a level straight street. He applies a constant 100 N force.

a. The work Roger does on the skateboard is 0 J.
b. The work Roger does on the skateboard is 1 300 J.
c. The work Sally does on the skateboard is 1 300 J.
d. The work Sally does on the skateboard is 5 850 J.
e. The work Roger does on the skateboard is 5 850 J.

ANS: B PTS: 1 DIF: Easy

60. Negative work can be done

a. by friction on the tires while a car is accelerating without skidding.
b. by a spring at the bottom of an elevator shaft when it stops a falling elevator.
c. by a hand catching a ball.
d. by all of the above.
e. only by (b) and (c) above.

ANS: E PTS: 1 DIF: Easy

61. Positive work can be done

a. by friction on the tires when a car is accelerating without skidding.
b. by a spring when it launches a clown in the air.
c. by a hand throwing a ball.
d. by all of the above.
e. only by (b) and (c) above.

$W = \Delta KE$

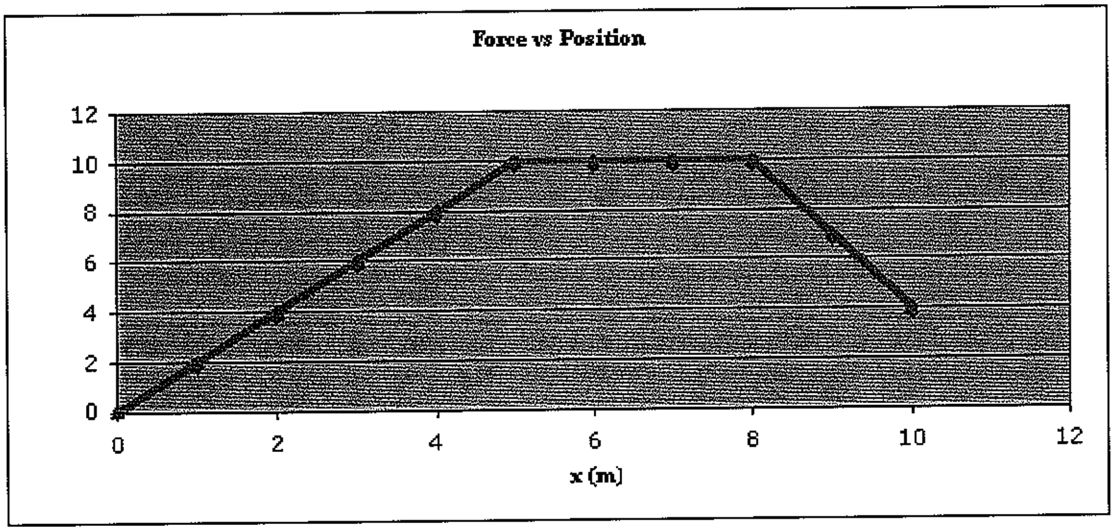
ANS: E PTS: 1 DIF: Easy

62. The force of static friction exerted on an automobile's tires by the ground

a. provides the accelerating force that makes the car move forward.
b. does positive work on the car while it is accelerating.
c. does negative work on the car while it is decelerating.
d. does everything listed in (a), (b) and (c).
e. only does positive or negative work as in (b) or (c).

ANS: A PTS: 1 DIF: Easy

63. The graph below shows how the force on a 0.500 kg particle varies with position. If the particle has speed $v = 2.23\frac{\text{m}}{\text{s}}$ at $x = 0.00$ m, what is its speed in m/s when $x = 8.00$ m?



a. 2.00
b. 10.7
c. 14.8
d. 15.0
e. 21.1

ANS: D PTS: 2 DIF: Average

64. The equation below is the solution to a physics problem:

$$\frac{1}{2}(2.30\text{ kg})\left(3.90\frac{\text{m}}{\text{s}}\right)^2 = \frac{1}{2}(2.30\text{ kg})\left(2.33\frac{\text{m}}{\text{s}}\right)^2 + (2.30\text{ kg})\left(9.80\frac{\text{m}}{\text{s}^2}\right)(1.00\text{ m})\cos(60°).$$

The most likely physical situation it describes is
a. a 2.30 kg cart rolling up a 30° incline.
b. a 2.30 kg cart rolling down a 30° incline.
c. a 2.30 kg cart rolling up a 60° incline.
d. a 2.30 kg cart rolling down a 60° incline.
e. a 2.30 kg cart rolling down a 90° incline.

ANS: B PTS: 2 DIF: Average

65. After a skydiver reaches terminal velocity,
a. the force of gravity no longer performs work on the skydiver.
b. work performed by the force of gravity is converted into gravitational potential energy.
c. gravitational potential energy is no longer available to the system of the skydiver plus the Earth.
d. gravitational potential energy is converted into thermal energy.
e. thermal energy is converted into gravitational potential energy.

ANS: D PTS: 1 DIF: Easy

66. Each of two vectors, $\vec{\mathbf{D}}_1$ and $\vec{\mathbf{D}}_2$, lies along a coordinate axis in the *xy* plane. Each vector has its tail at the origin, and the dot product of the two vectors is $\vec{\mathbf{D}}_1 \bullet \vec{\mathbf{D}}_2 = 0$. Which possibility is correct?
a. $\vec{\mathbf{D}}_1$ and $\vec{\mathbf{D}}_2$ both lie along the positive *x* axis.

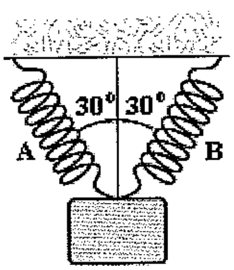
b. $\vec{D}_1$ lies along the positive x axis. $\vec{D}_2$ lies along the negative x axis.
c. $\vec{D}_1$ and $\vec{D}_2$ both lie along the positive y axis.
d. $\vec{D}_1$ lies along the negative x axis. $\vec{D}_2$ lies along the negative y axis.
e. $\vec{D}_1$ lies along the positive y axis. $\vec{D}_2$ lies along the negative y axis.

ANS: D PTS: 1 DIF: Easy

67. Each of two vectors, $\vec{D}_1$ and $\vec{D}_2$, lies along a coordinate axis in the xy plane. Each vector has its tail at the origin, and the dot product of the two vectors is $\vec{D}_1 \bullet \vec{D}_2 = -\left|\vec{D}_1\right|\left|\vec{D}_2\right|$. Which possibility is correct?
a. $\vec{D}_1$ and $\vec{D}_2$ both lie along the positive x axis.
b. $\vec{D}_1$ lies along the positive x axis. $\vec{D}_2$ lies along the negative x axis.
c. $\vec{D}_1$ and $\vec{D}_2$ both lie along the positive y axis.
d. $\vec{D}_1$ lies along the negative x axis. $\vec{D}_2$ lies along the negative y axis.
e. $\vec{D}_1$ lies along the positive y axis. $\vec{D}_2$ lies along the negative x axis.

ANS: B PTS: 1 DIF: Easy

68. Two identical springs with spring constant 50 N/m support a 5.0 N weight as in the picture below. What is the change in length of each spring when the weight is hung on the springs?



a. 2.9 cm
b. 5.0 cm
c. 5.8 cm
d. 7.5 cm
e. 10.0 cm

ANS: C PTS: 2 DIF: Average

69. A baseball is thrown and lands 120 m away. While the ball is in flight, assuming the effect of air friction is negligible, which of the following is true?
a. At maximum height the ball has its greatest kinetic energy.
b. The horizontal component of the baseball's kinetic energy is constant.
c. The vertical component of the baseball's kinetic energy is constant.
d. The mechanical energy of the baseball is greater when nearer to the ground.
e. No answer above is correct.

ANS: E PTS: 1 DIF: Easy

70. A moving particle is subject to conservative forces only. When its kinetic energy decreases by 10 J, what happens to its mechanical energy?

a. It increases by 10 J.
b. It decreases by 10 J.
c. It increases, but not necessarily by 10 J.
d. It decreases, but not necessarily by 10 J.
e. It remains the same.

ANS: E PTS: 1 DIF: Easy

71. A conservative force on a particle moving along the x axis is given by $\vec{\mathbf{F}} = (3x^2 - 2x)\hat{\mathbf{i}}$. Which of the following is a potential that is associated with this force?

a. $(6x - 2)\hat{\mathbf{i}}$
b. $(-6x + 2)\hat{\mathbf{i}}$
c. $x^3 - x^2 + 3$
d. $-x^3 + x^2 + 3$
e. No answer given above is correct.

$W = \vec{F}\cdot\vec{d} = -\Delta U$, $\Delta U = -\int F\, dx$

$U - 0 = -\int F\, dx$

$U = -\frac{3x^3}{3} + \frac{2x^2}{2} + \text{Const} = -x^3 + x^2 + \text{Const}$

ANS: D PTS: 2 DIF: Average

72. A particle is subject to the potential $U = 2x^2y + 6y$. What is the value of the y component of the force on the particle at the point $(x, y) = (2.0, 3.0)$?

a. 24
b. −24
c. 14
d. −14
e. 28

$F_y = -\frac{dU}{dy} = -(2x^2 + 6)$

$F_y(2,3) = -(2(2)^2 + 6) = -14$ J

ANS: D PTS: 2 DIF: Average

PROBLEM

73. A baseball outfielder throws a baseball of mass 0.15 kg at a speed of 40 m/s and initial angle of 30°. What is the kinetic energy of the baseball at the highest point of the trajectory?

$V = \sqrt{v_x^2 + v_y^2}$ at highest point $v_y = 0$

V_x is Const and $= V_0 \cos\theta$

$K = \frac{1}{2}mv^2 = \frac{1}{2}(0.15)\, V_0^2 \cos^2\theta = 90$ J

ANS:
90 J

PTS: 2 DIF: Average

74. For the potential $U = 2x^2 - 8x$, find the stable equilibrium point, if any.

at stable eq. $\frac{dU}{dx} = 0 = 4x - 8$

$x = \frac{8}{4} = 2$

ANS:
$x = 2$

PTS: 3 DIF: Challenging