Physics 101

Chapter 2

Motion in One Dimension

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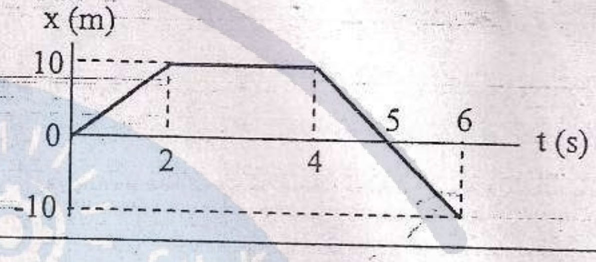
Chapter 2
Motion in One Dimension

1] A particle is moving along the x-direction. Its displacement as a function of time is shown in the figure below. The average speed (in m/s) of the particle over the time interval (0 to 5) seconds is:



a) 4 b) 0
c) 1.5 d) 6
e) 35

2] A particle moving along the x-axis has a position given by $x = 18t - 3t^2$ where x is in meters and t in seconds. How far is the particle from the origin when the particle changes its direction ?

a) 23 m b) 32 m c) 40 m d) 27 m e) 0

3] The position of a particle as a function of time is given by the relation $x = at + bt^2$. At t = 0 the velocity of the particle is 4 m/s, at (t = 1s) the particle's velocity is reduced to 1 m/s. The velocity of this particle at (t = 3s) is (in m/s):

a) 1 b) -5 c) -2 d) -1 e) 3

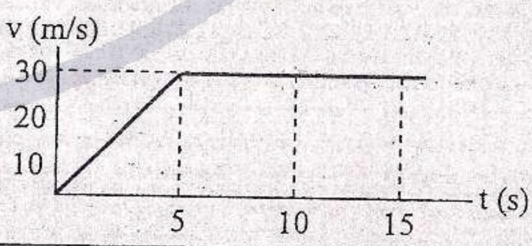
4] A stone is projected vertically up wards with an initial speed of 20 m/s. When the stone reaches its maximum height the acceleration of the stone is (in m/s^2):

a) 0 b) 10 upward c) 10 downward
d) cannot be determined e) non of the above is correct

5] The position of a particle moving along the x-axis is given by: $x = 3t^3 - 12t^2 + 4$, where x is in meter and t is in second. The average acceleration (m/s^2) of the particle during the time interval (t = 1s) to (t = 3s) is :

a) -12 b) -4 c) 12 d) 4 e) 18

6] The graph beside shows the instantaneous velocity of a car during 15s of its motion. The distance (in m) traveled by this car during the first 10s interval is:



a) 30 b) 225 c) 300
d) 75 e) 375

7] A ball is thrown vertically upward with a speed of 27 m/s from the top of a cliff which is 29.6 m high. The time it takes the ball to reach the ground (in s) is:

a) 7 b) 3 c) 6.4 d) 11 e) 1.5

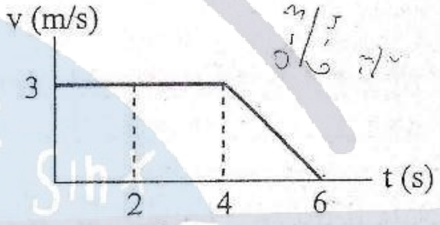
8] The motion of a particle along the x-axis is described by the equation $x = 20 + 4t^2$, where x is in meter and t in second. The instantaneous velocity (m/s) and acceleration (m/s^2) at t = 2s are:

a) 8 , 4 b) 8 , 16 c) 16 , 4 d) 16 , 8 e) 4 , 8

9] The position of a particle moving along the x-axis is given by $x = 6t^2 - t^3$, where x is in meters and t in seconds. What is the position of the particle when it achieves its maximum speed in the positive x direction? :

a) 16m b) 12m c) 32m d) 24m e) 2m

10] The graph shown beside represents the velocity of a particle as a function of time. The acceleration (in m/s^2) of the particle at t = 5s is:

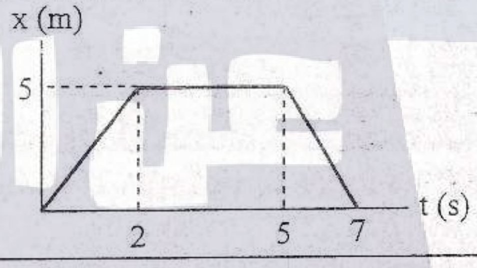


a) –1.7 b) –1.5 c) 1.8
d) 3 e) 2.6

11] An object is moving in a straight line. At t = 0 its speed is 5 m/s. From t = 0 to t = 4, its acceleration is 5 m/s^2 . From t = 4s to t = 11s, its speed is constant. The average speed (in m/s) over the entire time interval is:

a) 9.5 b) 15 c) 13 d) 21 e) 8.2

12] Refer to the graph shown beside, the displacement (in m) between t = 0 and t = 5s is:



a) zero b) 5 c) 10
d) 15 e)25

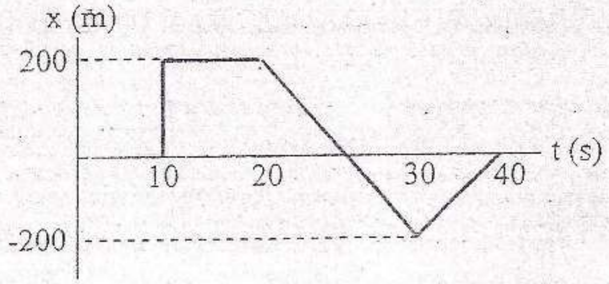
13] In 2s, a particle moving with constant acceleration along the x-axis goes from x = 10 m to x = 50 m. The velocity at the end of this time interval is 10 m/s. The acceleration of the particle is:

a) 15 m/s^2 b) 20 m/s^2 c) -20 m/s^2 d) -10 m/s^2 e) -15 m/s^2

14] An object is thrown vertically and has an upward velocity of 18 m/s when it reaches one forth of its maximum height above its launch point. What is the initial (launch) speed of the object?:

a) 35 m/s b) 21 m/s c) 30 m/s d) 25 m/s e) 17 m/s

15] From the position versus time graph of the figure, the magnitude of the average velocity from t = 0 to t = 30s (in m/s) is



a) 6.7 b) 10.0
c) 40.0 d) 65.0
e) 80.0

16] A particle starts from rest at x = 0 and moves for 10s with an acceleration of 2 cm/s^2. For the next 20s, the acceleration of the particle is -1 cm/s^2 . What is the position of the particle at the end of this motion? :

a) zero b) 2 m c) –1 m d) 3 m e) -3 m

17] A truck covers 40 m in 8.5 seconds while smoothly slowing down to a final speed of 2.8 m/s. It's original speed (in m/s) is:

a) 4.3 b) 12.2 c) 9.9 d) 6.6 e) 78.2

18] A ball thrown vertically from ground level is caught 3.0 s later by a person on a balcony which is 14 m above the ground. Determine the initial speed of the ball.

a) 19 m/s b) 4.7 m/s c) 10 m/s d) 34 m/s e) 17 m/s

19] The relationship between the velocity of a body moving along the x axis and time is given by $v = 3t^2 - 2t$, where the units are SI units. The total distance the body travels between the times t = 2s and t = 4s is:

a) 12 m b) 60 m c) 48 m d) 34 m e) 44 m

20] A racing car moves along one dimension with constant acceleration a = 3 m/s^2. If its initial speed was 15 m/s, then its speed (in m/s) after moving 30 m is:

a) -20.1 b) 20.1 c) 6.7 d) 17.7 e) 28.7

21] A particle moving along the x-axis has a position given by $x = (24t - 2t^3)$ m, where t is measured in s. what is the magnitude of the acceleration of the particle when the particle is not moving?

a) 24 m/s^2 b) zero c) 12 m/s^2 d) 48 m/s^2 e) 36 m/s^2

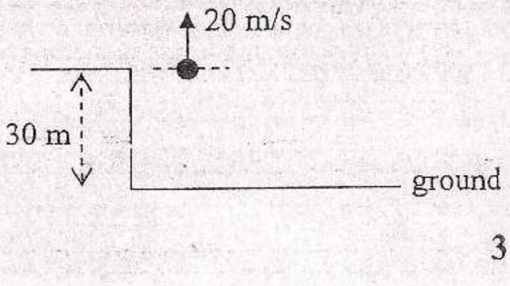
22] A ball is thrown directly downward with an initial velocity of 8 m/s from a height of 25 m. The time (in s) it takes to strike the ground is:

a) 2.5 b) 1.6 c) 3.4 d) 1.8 e) 3.16

23] The position of a particle moving along the x axis is given by $x = (21 + 22t - 6t^2)$ m, where t is in second. What is the average velocity during the time interval t = 0 to t = 3 s?

a) -2 m/s b) -4 m/s c) 4 m/s d) 8 m/s e) -8 m/s

24] A stone is thrown vertically upward as shown in the figure beside. The time (in s) needed for the stone to reach the ground is:



a) 1.2 b) 3.1 c) 5.2
d) 4.3 e) 2.1

1] average speed $= \dfrac{\text{distance}}{\text{time interval}} = \dfrac{20}{5} = 4m/s$ **a**

2] $x = 18t - 3t^2 \Rightarrow v = 18 - 6t$

$v = 0 = 18 - 6t \Rightarrow t = 3s$

$x(3) = (18)(3) - (3)(3)^2 = 27m$ **d**

3] $x = at + bt^2 \Rightarrow v = a + 2bt$

$$\left\{\begin{array}{l} \text{at t} = 0 \Rightarrow v = 4 \Rightarrow a = 4 \\ \text{at t} = 1 \Rightarrow v = 1 = 4 + 2b \Rightarrow b = -\dfrac{3}{2} \end{array}\right\} v = 4 - 3t$$

$v(3) = 4 - (3)(3) = -5m/s$ **b**

4] $g = 10\ m/s^2$ downward **c**

5] $\bar{a} = \dfrac{v_f - v_i}{t_f - t_i} = \dfrac{v(3) - v(1)}{3 - 1}$

$x(t) = 3t^3 - 12t + 4$

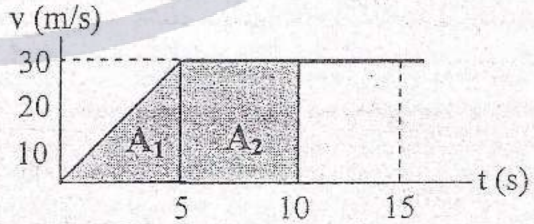
$v(t) = 9t^2 - 24t$

$v(3) = (9)(3)^2 - (24)(3) = 81 - 72 = 9$

$v(1) = (9)(1)^2 - (24)(1) = 9 - 24 = -15$

$\bar{a} = \dfrac{9 - (-15)}{3 - 1} = \dfrac{24}{2} = 12\,m/s^2$ **c**

6] distance $= \int_{t_2}^{t_1} v\,dt$ = area



$A_1 = (\dfrac{1}{2})(5)(30) = 75m$

$A_2 = (5)(30) = 150m$

distance $= A_1 + A_2 = 75 + 150 = 225m$

b

7] from point (a) to point (b)

$v_f = v_i + at \Rightarrow 0 = 27 - 9.8t$

$27 = 9.8t \Rightarrow t = \frac{27}{9.8} = 2.75s$

$\Delta y_2 = v_1 t + \frac{1}{2}at^2 = (27)(2.75) + (\frac{1}{2})(-9.8)(2.75)^2$

$\Delta y_2 = 74.25 - 37.05 = 37.2m$

from point (b) to point (c)

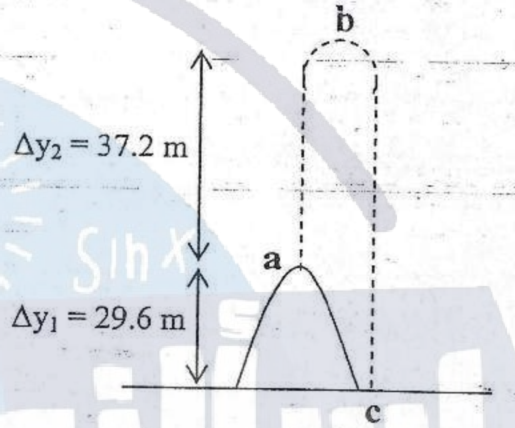
$\Delta y = y_1 + y_2 = 29.6 + 37.2 = 66.8m$

$\Delta y = v_2 t + \frac{1}{2}at^2 \Rightarrow 66.8 = (0)(t) + (\frac{1}{2})(9.8)(t^2)$

$66.8 = 4.9t^2 \Rightarrow t^2 = \frac{66.8}{4.9} = 13.63$

$t = \sqrt{13.63} = 3.7s$

total time $= 2.75 + 3.7 = 6.45s$



c

8] $x(t) = 20 + 4t^2$

$v(t) = 8t \Rightarrow v(2) = (8)(2) = 16\,m/s$

$a(t) = 8 \Rightarrow a(2) = 8\,m/s^2$

d

9] when (v) is maximum $\Rightarrow \frac{dv}{dt} = zero$

$x = 6t^2 - t^3$

$v(t) = 12t - 3t^2 \Rightarrow \frac{dv}{dt} = 12 - 6t = 0$

$12 = 6t \Rightarrow t = 2s$

$x(2) = (6)(2^2) - (2^3) = 24 - 8 = 16m$

a

10] $a = \frac{dv}{dt} = slope$

$a(t=5) = \frac{dv}{dt}\Big|_{t=5} = slope$

$slope = \frac{0-3}{6-4} = \frac{-3}{2} = -1.5 \quad m/s^2$

b

11] average speed $= \dfrac{\text{distance}}{\text{time interval}}$

from point (a) to point (b)

$$\Delta x_1 = v_1 t + \frac{1}{2}at^2 = (5)(4) + (\frac{1}{2})(5)(16) = 20 + 40 = 60m$$

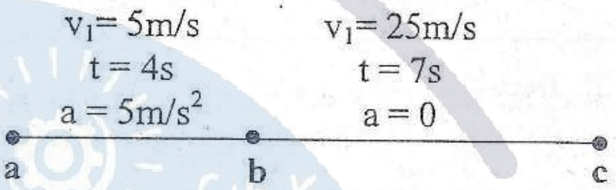
$$v_2 = v_1 + at = (5) + (5)(4) = 25m/s$$

from point (b) to point (c)

$$\Delta x_2 = v_1 t + \frac{1}{2}at^2 = (25)(7) + (\frac{1}{2})(0)(49) = 175m$$

$$\Delta x = \Delta x_1 + \Delta x_2 = 60 + 175 = 235m$$

$$\text{average speed} = \frac{235}{11} = 21.3m/s$$



d

12] displacement $= \Delta x = x_2 - x_1$

$$\Delta x = x(t = 5) - x(t = 0) = 5 - 0 = 5m$$

b

13] $v_f = v_i + at \;\Rightarrow\; 10 = v_i + (a)(2)$

$10 = v_i + 2a \ldots\ldots (1)$

$\Delta x = v_i t + \frac{1}{2}at^2 \;\Rightarrow\; 40 = (v_i)(2) + (\frac{1}{2})(a)(4)$

$40 = 2v_i + 2a \ldots\ldots (2)$

$$\left\{\begin{aligned} 10 &= v_i + 2a \ldots\ldots (1) \\ 40 &= 2v_i + 2a \ldots\ldots (2) \end{aligned}\right\} a = -10m/s^2$$

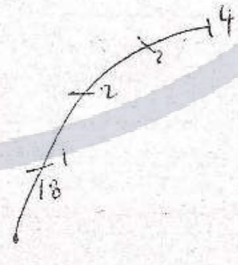
بالطرح
$10 = V_o + 2a$ (1)
$40 = 2V_o = 2a$ (2)
$-30 = -V_o$
$V_o = 30$
بالتعويض (1)
$10 = 30 + 2a \Rightarrow a = -10$

d

14] when $(\Delta y = \Delta y_{max}) \;\Rightarrow\; (v_f = 0)$

$v_f^2 = v_i^2 + 2a\Delta y \;\Rightarrow\; (0)^2 = v_i^2 + (2)(-9.8)(\Delta y_{max})$

$v_i^2 = 19.6\Delta y_{max} \;\Rightarrow\; \Delta y_{max} = \dfrac{v_i^2}{19.6} \ldots\ldots (1)$



when $(\Delta y = \frac{1}{4}\Delta y_{max}) \;\Rightarrow\; (v_f = 18m/s)$

$v_f^2 = v_i^2 + 2a\Delta y \;\Rightarrow\; (18)^2 = v_i^2 + (2)(-9.8)(\frac{1}{4}\Delta y_{max})$

$324 = v_i^2 - 4.9\Delta y_{max} \ldots\ldots (2)$

$324 = v_i^2 - (4.9)(\dfrac{v_i^2}{19.6})$

$324 = v_i^2 - 0.25v_i^2 = 0.75v_i^2$

$v_i^2 = \dfrac{324}{0.75} = 432 \;\Rightarrow\; v_i = \sqrt{432} = 20.8m/s$

b

15] $\bar{v} = \dfrac{\Delta x}{\Delta t} = \dfrac{x_f - x_i}{t_f - t_i} = \dfrac{-200-0}{30-0} = -6.7 m/s$

the magnitude of the average velocity $|\bar{v}| = 6.7 m/s$

a

16] from (t = 0) to (t = 10s)

$\Delta x_1 = v_1 t + \frac{1}{2}at^2 = (0)(10) + (\frac{1}{2})(2)(100) = 100cm$

$v_2 = v_1 + at = 0 + (2)(10) = 20cm/s$

from (t = 10s) to (t = 30s)

$\Delta x_2 = v_1 t + \frac{1}{2}at^2 = (20)(20) + (\frac{1}{2})(-1)(400) = 200cm$

$\Delta x = \Delta x_1 + \Delta x_2 = 100 + 200 = 300cm = 3m$

d

17] $v_f = v_i + at \Rightarrow 2.8 = v_i + (a)(8.5)$

$2.8 = v_i + 8.5a \ldots\ldots (1)$

$\Delta x = v_i t + \frac{1}{2}at^2 \Rightarrow 40 = (v_i)(8.5) + (\frac{1}{2})(a)(8.5^2)$

$40 = 8.5v_i + 36.125a \ldots\ldots (2)$

$\begin{cases} 2.8 = v_i + 8.5a \ldots\ldots (1) \\ 40 = 8.5v_i + 36.125a \ldots (2) \end{cases}$ $v_i = 6.6m/s$

نقسم ② على ÷ 8.5 ثم نطرح ①-②

$2.8 = V_0 + 8.5a$

$4.7 = V_0 + 4.25a$

$-1.9 = 4.25a$

$a = -0.44$

بالتعويض في ①

$2.8 = V_0 + 8.5 \times (-0.44)$

$V_0 = 6.54$

d

18] $\Delta y = v_i t + \frac{1}{2}at^2 \Rightarrow 14 = (v_i)(3) + (\frac{1}{2})(-9.8)(3^2)$

$14 = 3v_i - 44.1 \Rightarrow 3v_i = 58.1$

$v_i = 19.3m/s$

a

19] distance $= \int_{t_1}^{t_2} v\,dt = \int_{t=2}^{t=4} (3t^2 - 2t)dt = t^3 - t^2 \Big|_{t=2}^{t=4}$

distance $= [(4^3 - 4^2) - (2^3 - 2^2)] = 48 - 4 = 44m$

e

20] $v_f^2 = v_i^2 + 2a\Delta x$

$v_f^2 = (15^2) + (2)(3)(30) = 225 + 180 = 405$

$v_f = \sqrt{405} = 20.1m/s$

b

21] $x = 24t - 2t^3 \Rightarrow v = 24 - 6t^2 \Rightarrow a = -12t$

when the particle is not moving means ($v = 0$)

$0 = 24 - 6t^2 \Rightarrow t^2 = \dfrac{24}{6} = 4 \Rightarrow t = 2s$

$a(t = 2) = -(12)(2) = -24m/s^2$

the magnitude of the acceleration $|-24| = 24m/s^2$

a

22] $v_f^2 = v_i^2 + 2a\Delta y \Rightarrow v_f^2 = (8^2) + (2)(9.8)(25)$

$v_f^2 = 64 + 490 = 554 \Rightarrow v_f = \sqrt{554} = 23.54m/s$

$v_f = v_i + at \Rightarrow 23.54 = 8 + (9.8)(t)$

$15.54 = 9.8t \Rightarrow t = \dfrac{15.54}{9.8} = 1.6s$

$y = y_0 + v_0 t + \frac{1}{2}at^2$
$25 = 0 + 8 \times t + \frac{1}{2} \times 9.8 \times t^2$
$25 = 8t + 4.9t^2$
$4.9t^2 + 8t - 25 = 0$
وبعد التحليل
$t_1 = 1.58$
$t_2 = -3.21 \Rightarrow$ ignored
لأن الجسم لم يصعد لأعلى

b

23] $\bar{v} = \dfrac{\Delta x}{\Delta t} = \dfrac{x(3) - x(0)}{3 - 0}$

$x(3) = (21) + (22)(3) - (6)(3^2) = 33$

$x(0) = (21) + (22)(0) - (6)(0^2) = 21$

$\bar{v} = \dfrac{33 - 21}{3 - 0} = \dfrac{12}{3} = 4m/s$

c

24] from point (a) to point (b)

$v_f = v_i + at_1 \Rightarrow 0 = 20 + (-9.8)(t_1)$

$t_1 = \dfrac{20}{9.8} = 2s$

$\Delta y_1 = v_i t_1 + \dfrac{1}{2}at_1^2 \Rightarrow \Delta y_1 = (20)(2) + (\dfrac{1}{2})(-9.8)(2^2)$

$\Delta y_1 = 40 - 19.6 = 20.4m$

$\Delta y = 30 + \Delta y_1 = 30 + 20.4 = 50.4m$

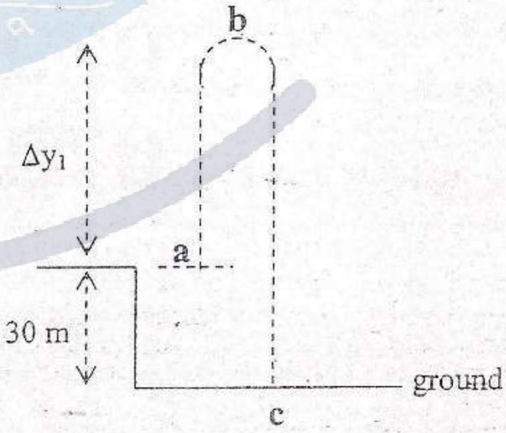
from point (b) to point (c)

$\Delta y = v_i t_2 + \dfrac{1}{2}at_2^2 \Rightarrow 50.4 = (0)(t_2) + (\dfrac{1}{2})(9.8)(t_2^2)$

$50.4 = 4.9t_2^2 \Rightarrow t_2^2 = \dfrac{50.4}{4.9} = 10.28$

$t_2 = \sqrt{10.28} = 3.2$

$t = t_1 + t_2 = 2 + 3.2 = 5.2s$



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Physics 101
Chapter 3

Vectors

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Chapter 3
Vectors

1] The angle between two vectors $\overline{A}$ and $\overline{B}$, that are starting from the same point is 60°. If $\overline{A} = 7i - j + 5k$ and $|B| = 7$. Then the scalar product of these two vectors is:

a) 30.3 b) 36.7 c) 63.6 d) 262 e) 52.5

2] Two vectors lying in the x-y plane given by: $\overline{A} = 5i + 2j$ and $\overline{B} = 2i + 3j$ (assuming the positive right-handed system). The $\overline{B} \times \overline{A}$ equals to:

a) $-19k$ b) $-11k$ c) $19k$ d) $11k$ e) $4k$

3] The angle between the vector $\overline{r} = 2i - j - 3k$ and the positive z-axis is:

a) 106° b) 75° c) 120° d) 94° e) 143°

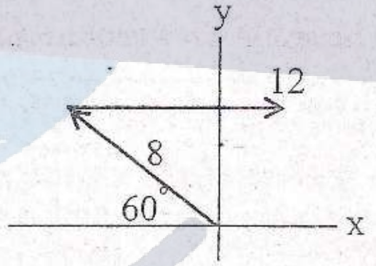
4] If vectors $\overline{A} = i - 2j + k$ and $\overline{B} = -3i + j - zk$ are perpendicular. The value of z is then:

a) -5 b) 5 c) 3 d) -6 e) 2

5] Three displacement vectors are in the same plane. They are expressed as $\overline{A} = 4i - j$, $\overline{B} = -3i + 2j$, $\overline{C} = -3j$. The vector $\overline{R}$ is defined as $\overline{R} = \overline{A} - \overline{B} + \overline{C}$. The magnitude of the vector $\overline{R}$ and the angle it makes with the positive x-axis are:

a) 5 ; 45° b) 9.2 ; -40.6° c) 2.2 ; -63.4°
d) 1.4 ; 45° e) 3 ; 0°

6] A particle makes two consecutive displacements. The magnitudes and directions of the displacements are shown in the figure below. The resultant displacement is:



a) $12i + 4\sqrt{3}j$ b) $-6i + 4\sqrt{3j}$ c) $-4i + 4\sqrt{3j}$
d) $-8i - 4\sqrt{3j}$ e) $8i + 4\sqrt{3j}$

7] If $\overline{A} = 2i + 3j - k$, $\overline{B} = i - j + 5k$ and $2\overline{A} + \overline{B} - \overline{C} = 0$, then the vector $\overline{C}$ is:

a) $5i + 5j + 3k$ b) $3i + 2j + 4k$ c) $6i + 4j + 8k$
d) $-5i - 5j - 3k$ e) $i + j + 4k$

8] If a vector $\overline{B}$ is added to vector $\overline{A}$, the result is $(6i + j)$, if $\overline{B}$ is subtracted from $\overline{A}$ the result is $(-4i + 7j)$. The magnitude of $\overline{A}$ is:

a) 5.1 b) 4.1 c) 5.4 d) 5.8 e) 8.2

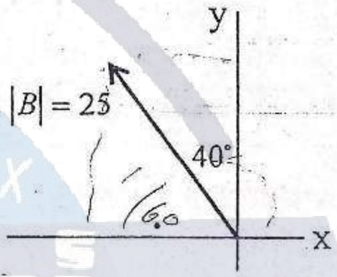
9] If $|\overline{A} \times \overline{B}| = \overline{A} \bullet \overline{B}$, the angle (in degrees) between $\overline{A}$ and $\overline{B}$ is:

a) 90 b) 75 c) 60 d) 55 e) 45

10] Two vectors $\overline{A} = 5i + 6j + 7k$, and $\overline{B} = 3i - 8j + 2k$. If these two vectors are drawn starting at the same point. What is the angle between them?:

a) 106°   b) 113°   c) 110°   d) 102°   e) 79°

11] If $\overline{A} = 28i + 11j$ and $\overline{B}$ is as shown. What is the magnitude of the sum of these two vectors?:



a) 45   b) 35   c) 32
d) 39   e) 64

12] Vector $\overline{B}$, when added to the vector $\overline{C} = 3i + 4j$ yields a resultant vector, which is in the positive y-direction, and has a magnitude equal to that of $\overline{C}$. What is the magnitude of $\overline{B}$?:

a) 6.3   b) 3.2   c) 9.5   d) 18   e) 5

13] Two vectors lying in the xz-plane are given by $\overline{A} = 2i + 3k$, $\overline{B} = -i + 2k$. The vector $\overline{A} \times \overline{B}$ is:

a) j b) $-j$ c) $7k$ d) $-7j$ e) $i + 5k$

14] The angle between the vector $\overline{B} = i + 2j + 2k$ and the positive z-axis is:

a) $\cos^{-1}(\frac{-2}{3})$ b) $\cos^{-1}(\frac{2}{3})$ c) $\cos^{-1}(\frac{3}{2})$ d) $\cos^{-1}(\frac{-3}{2})$ e) $\cos^{-1}(\frac{1}{3})$

15] If $\overline{A} = 2i - 4j + 5k$, and $\overline{A} = 2\overline{B}$ then the projection of the vector $\overline{B}$ on the x-axis is:

a) 1   b) 2   c) 2.5   d) 5   e) 10

16] Let $\vec{A} = 4i + 6j - 3k$ and $\vec{B} = 4i + 4j + k$. The vector $\vec{S} = 2\vec{A} + 3\vec{B}$ equals:

a) 16i + 18j – 3k   b) -2i + 4j -4k
c) 2i – 4j + 4k   d) 20i + 24j – 3k
e) none of these

17] If two vectors given as $\vec{A} = 3.0i + 7.0j$ and $\vec{B} = 4.0i + 4.0j$; then the magnitude of their vector (cross) product is:

a) 20   b) 16   c) 6.0   d) 36   e) 40

18] Two vectors lying in the xz plane are given by: $\vec{A} = 2i + 3k$ and $\vec{B} = -i + 2k$. The angle (in degrees) between the two vectors $\vec{A}$ and $\vec{B}$ is:

a) 60   b) 30   c) 120   d) 150   e) 90

1] $\overline{A} \bullet \overline{B} = |A||B|\cos\theta$

$|A| = \sqrt{(7)^2 + (-1)^2 + (5)^2} = \sqrt{75} = 8.66$

$\overline{A} \bullet \overline{B} = (8.66)(7)\cos 60^\circ = 30.3$

a

2] $\overline{B} \times \overline{A} = \begin{vmatrix} i & j & k \\ B_x & B_y & B_z \\ A_x & A_y & A_z \end{vmatrix} = \begin{vmatrix} i & j & k \\ 2 & 3 & 0 \\ 5 & 2 & 0 \end{vmatrix} = 0i - 0j + [(2)(2) - (5)(3)]k = [4 - 15]k = -11k$

b

3] $\theta_{r,z} = \cos^{-1}(\frac{r_z}{|r|}) = \cos^{-1}(\frac{-3}{\sqrt{(2)^2 + (-1)^2 + (-3)^2}})$

$= \cos^{-1}(\frac{-3}{\sqrt{14}}) = \cos^{-1}(-0.8) \quad \Rightarrow \quad \theta = 143^\circ$

e

4] $\overline{A} \bullet \overline{B} = |A||B|\cos 90^\circ = 0 \; ......(1)$

$\overline{A} \bullet \overline{B} = (A_x B_x) + (A_y B_y) + (A_z B_z) = (1)(-3) + (-2)(1) + (1)(-z) = -3 - 2 - z = -5 - z \; ......(2)$

$(1) = (2) \quad \Rightarrow \quad 0 = -5 - z \quad \Rightarrow \quad z = -5$

a

5] $\overline{R} = \overline{A} - \overline{B} + \overline{C} = (4i - j) - (-3i + 2j) + (-3j)$

$\overline{R} = 7i - 6j \quad \Rightarrow \quad |R| = \sqrt{(7)^2 + (-6)^2} = \sqrt{85} = 9.2$

$\theta_{R,x} = \cos^{-1}(\frac{R_x}{|R|}) = \cos^{-1}(\frac{7}{9.2}) = \cos^{-1}(0.76) \quad \Rightarrow \quad \theta = 40.6^\circ$

but this angle in the forth quarter because R_y is negative

b

6] the first displacement

$A_x = A\cos\theta = (8)\cos 120^\circ = (8)(-0.5) = -4$

$A_y = A\sin\theta = (8)\sin 120^\circ = (8)(\frac{\sqrt{3}}{2}) = 4\sqrt{3}$

$\overline{A} = -4i + 4\sqrt{3}j$

the second displacement

$B_x = B\cos\theta = (12)\cos 0^\circ = (12)(1) = 12$

$B_y = B\sin\theta = (12)\sin 0^\circ = (12)(0) = 0$

$\overline{B} = 12i$

e

the resultant displacement

$\overline{A} + \overline{B} = (-4i + 4\sqrt{3}j) + (12i) = 8i + 4\sqrt{3}j$

7] $2\overline{A} = 2(2i + 3j - k) = 4i + 6j - 2k$

$2\overline{A} + \overline{B} - \overline{C} = 0 \quad \Rightarrow \quad 2\overline{A} + \overline{B} = \overline{C}$

$\overline{C} = (4i + 6j - 2k) + (i - j + 5k) = 5i + 5j + 3k$

a

8] $\overline{A} = A_x i + A_y j \quad , \quad \overline{B} = B_x i + B_y j$

$\overline{A} + \overline{B} = (A_x + B_x)i + (A_y + B_y)j = 6i + j$

$\therefore A_x + B_x = 6 \qquad A_y + B_y = 1 \ldots\ldots (1)$

$\overline{A} - \overline{B} = (A_x - B_x)i + (A_y - B_y)j = -4i + 7j$

$\therefore A_x - B_x = -4 \qquad A_y - B_y = 7 \ldots\ldots (2)$

$\left.\begin{cases} \overline{A} = i + 4j \\ \overline{B} = 5i - 3j \end{cases}\right\} \Rightarrow |A| = \sqrt{(1)^2 + (4)^2} = \sqrt{17} = 4.1$

b

9] $|\overline{A} \times \overline{B}| = |A||B|\sin\theta \ldots\ldots (1)$

$\overline{A} \bullet \overline{B} = |A||B|\cos\theta \ldots\ldots (2)$

$(1) = (2) \quad \Rightarrow \quad |A||B|\sin\theta = |A||B|\cos\theta \quad \Rightarrow \quad \sin\theta = \cos\theta$

$\dfrac{\sin\theta}{\cos\theta} = 1 = \tan\theta \quad \Rightarrow \quad \theta = 45^\circ$

e

10] $\overline{A} \bullet \overline{B} = A_x B_x + A_y B_y + A_z B_z = (5)(3) + (6)(-8) + (7)(2)$

$= 15 - 48 + 14 = -19 \ldots\ldots (1)$

$\overline{A} \bullet \overline{B} = |A||B|\cos\theta$

$|A| = \sqrt{(5)^2 + (6)^2 + (7)^2} = \sqrt{110} = 10.5 \quad , \quad |B| = \sqrt{(3)^2 + (-8)^2 + (2)^2} = \sqrt{77} = 8.8$

$\therefore \overline{A} \bullet \overline{B} = (10.5)(8.8)\cos\theta = 92.4\cos\theta \ldots\ldots (2)$

$(1) = (2) \quad \Rightarrow \quad -19 = 92.4\cos\theta \quad \Rightarrow \quad \cos\theta = \dfrac{-19}{92.4} = -0.2$

$\theta = \cos^{-1}(-0.2) = 102^\circ$

d

11] $B_x = B\cos\theta = (25)\cos 130^\circ = (25)(-0.64) = -16$

$B_y = B\sin\theta = (25)\sin 130^\circ = (25)(0.77) = 19.25$

$\therefore \overline{B} = -16i + 19.25j$

$\overline{A} + \overline{B} = (28i + 11j) + (-16i + 19.25j) = 12i + 30.25j$

$|\overline{A} + \overline{B}| = \sqrt{(12)^2 + (30.25)^2} = \sqrt{1059} \approx 32$

c

12] $|C| = \sqrt{(3)^2 + (4)^2} = \sqrt{25} = 5$

let $\overrightarrow{D} = \overrightarrow{B} + \overrightarrow{C} \Rightarrow |D| = 5 \Rightarrow \overrightarrow{D} = 5j$

$\overrightarrow{B} = \overrightarrow{D} - \overrightarrow{C} \Rightarrow \overrightarrow{B} = (5j) - (3i + 4j) = -3i + j$

$|B| = \sqrt{(-3)^2 + (1)^2} = \sqrt{10} \approx 3.2$

b

13] $\overrightarrow{A} \times \overrightarrow{B} = \begin{vmatrix} i & j & k \\ 2 & 0 & 3 \\ -1 & 0 & 2 \end{vmatrix} = 0i - [(2)(2) - (3)(-1)]j + 0k = -[4 - (-3)]j = -7j$

d

14] $\theta_{B,z} = \cos^{-1}(\frac{B_z}{|B|}) = \cos^{-1}(\frac{2}{\sqrt{9}}) = \cos^{-1}(\frac{2}{3})$

b

15] $\overrightarrow{A} = 2\overrightarrow{B} \quad \overrightarrow{B} = \frac{1}{2}\overrightarrow{A} = i - 2j + 2.5k \Rightarrow B_x = 1$

a

16] $A = 4i + 6j - 3k \Rightarrow 2A = 8i + 12j - 6k$

$B = 4i + 4j + k \Rightarrow 3B = 12i + 12j + 3k$

$S = 2A + 3B = (8i + 12j - 6k) + (12i + 12j + 3k)$

$S = 20i + 24j - 3k$

d

17] $\overrightarrow{A} \times \overrightarrow{B} = \begin{vmatrix} i & j & k \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix} = \begin{vmatrix} i & j & k \\ 3 & 7 & 0 \\ 4 & 4 & 0 \end{vmatrix} = 0i - 0j + [(3)(4) - (7)(4)]k = [12 - 28]k = -16k$

$|\overrightarrow{A} \times \overrightarrow{B}| = \sqrt{0^2 + 0^2 + (-16)^2} = 16$

b

18] $A = 2i + 3k \Rightarrow |A| = \sqrt{2^2 + 3^2} = \sqrt{13} = 3.6$

$B = -i + 2k \Rightarrow |B| = \sqrt{(-1)^2 + 2^2} = \sqrt{5} = 2.23$

$A \bullet B = |A||B|\cos\theta = (3.6)(2.23)\cos\theta = 8\cos\theta \ldots\ldots (1)$

$A \bullet B = (2i + 3k) \bullet (-i + 2k) = -2 + 6 = 4 \ldots\ldots (2)$

$(1) = (2) \Rightarrow 8\cos\theta = 4 \Rightarrow \cos\theta = \frac{4}{8} = 0.5$

$\theta = \cos^{-1} 0.5 = 60°$

a

Physics 101

Chapter 4

Motion in Two Dimensions

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Chapter 4
Motion in Two Dimensions

1] A projectile was fired at 35° above the horizontal. At the highest point in its trajectory, its speed was $200\,m/s$. The initial velocity had a vertical component (in m/s) is:

a) 0 b) 140 c) 115 d) 164 e) 200

2] An arrow is fired from ground with an initial velocity of $20\,m/s$, at an angle of 37° with the horizontal. How long (in seconds) dose the arrow stay in the air?

a) 1.20 b) 0.26 c) 4.00 d) 0.80 e) 2.41

3] A particle moves at a constant speed in a circular path with a radius of $2.0\,cm$. If the particle makes four revolutions each second, then the magnitude of its acceleration is:

a) $13\,m/s^2$ b) $18\,m/s^2$ c) $20\,m/s^2$ d) $15\,m/s^2$ e) $24\,m/s^2$

4] An airplane flies horizontally with a speed of $300\,m/s$ at an altitude of $400\,m$. Assume that the ground is level. What horizontal distance (in km) from a target on ground must the pilot release a bomb so as to hit the target?

a) 3.0 b) 2.4 c) 3.3 d) 2.7 e) 1.7

5] A projectile is thrown from the top of a building with an initial velocity of $30\,m/s$ in the horizontal direction. If the top of the building is $30\,m$ above the ground, how fast will the projectile be moving just before it strikes the ground?

a) $35\,m/s$ b) $54\,m/s$ c) $31\,m/s$ d) $43\,m/s$ e) $39\,m/s$

6] An object is placed $0.5\,m$ from the center of a horizontal rotating table. If the centripetal acceleration of the object is $18.0\,m/s^2$, the number of revolution per minute that the object makes is:

a) 57.3 b) 38.2 c) 94.2 d) 62.8 e) 377

7] An object initially at the origin has a velocity $v_\circ = (4i - 6j)\,m/s$, 10 seconds later the object has a velocity of $v = (12i + 6j)\,m/s$. The average acceleration (m/s^2) of the object is:

a) $0.8i - 1.2j$ b) $1.6i$ c) $0.8i + 1.2j$ d) $0.8i$ e) $1.6i + 1.2j$

8] The initial position and velocity of a particle are respectively given by: $\bar{r}_\circ = 2i + j$ in (m) and $\bar{v}_\circ = i - 2j$ in (m/s). If the acceleration of the particle is $\bar{a} = -i + j$ in (m/s^2) then the magnitude of the position vector in (m) at $t = 2s$ is:

a) 5.0 b) 2.7 c) 2.0 d) 1.5 e) 2.2

9] A particle starts from the origin at $t = 0$ with a velocity of $(16i - 12j)\,m/s$ and moves in the xy-plane with a constant acceleration of $\vec{a} = (3.0i - 6.0j)\,m/s^2$. What is the speed of the particle at $t = 2.0s$?
a) $52\,m/s$ b) $33\,m/s$ c) $46\,m/s$ d) $39\,m/s$ e) $43\,m/s$

10] A football is kicked off with an initial speed of $20.0\,m/s$ at an angle of 60° to the horizontal. When the football at the maximum height the speed is:
a) 17.4 b) 20 c) 0 d) 6.8 e) 10

11] A projectile is fired with an initial speed of $1000\,m/s$ at an angle of 53° above the horizontal. If air resistance is neglected, the horizontal component of the projectile's velocity (in m/s) after $20s$ is approximately:
a) 40 b) 160 c) 800 d) 600 e) 640

12] A particle initially located at the origin has an initial velocity $\vec{v}_o = 6i\,m/s$ and is moving with a constant acceleration $\vec{a} = 3j\,m/s^2$. The position vector of the particle at $t = 2s$ (in m) is:
a) $5i + 6j$ b) $10i + 6j$ c) $10i + 12j$ d) $12i + 6j$ e) $6i + 12j$

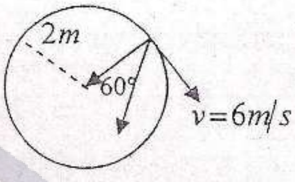
13] A car going around a curve of radius R at a speed v experiences a centripetal acceleration a_c. If it goes around a curve of radius $3R$ at a speed of $2v$ its acceleration becomes:
a) $(2/3)a_c$ b) $(4/3)a_c$ c) $(2/9)a_c$ d) $(9/2)a_c$ e) $(3/2)a_c$

14] A particle travels in a circular path of circumference $8m$ and makes 5.0 revolution per second. The acceleration a_c toward the center (in m/s^2) is:
a) 942.4 b) 314.1 c) 628.3 d) 1256.6 e) 230.7

15] At $t = 0$ a particle leaves the origin with velocity of $5.0\,m/s$ in the positive y-direction. Its acceleration is given by $\vec{a} = (3.0i - 2.0j)\,m/s^2$. At the instant the particle reaches Its maximum y coordinate how far is the particle from the origin?
a) $29\,m$ b) $16\,m$ c) $22\,m$ d) $11\,m$ e) $19\,m$

16] A firefighter 80 m away from a building directs a stream of water from a fire hose at an angle of 30° above the horizontal. If the initial speed of the stream is 60 m/s, then at what height (in meters) will the water strike the building?
a) 35 b) 28 c) 17 d) 8.5 e) 20

17] A particle performs circular motion in a vertical plane. At a certain instant the speed of the particle is $6\,m/s$ and the direction of its total acceleration is as shown in the figure beside. The magnitude of the tangential acceleration (in m/s^2) is :



a) 19.9 b) 23.1 c) 14.7 d) 18.0 e) 31.2

18] A ball is thrown with speed V_0 at an angle of 45° with the horizontal, from a point 20 meters away from a vertical wall. If the ball hits the wall at a height of 10 meters. The initial speed of the ball (in m/s) is:

a) 14 b) 28 c) 40 d) 17 e) 20

1] at highest point ($v_y = 0$)

$v = \sqrt{v_x^2 + v_y^2} \Rightarrow 200 = \sqrt{v_x^2 + 0^2} \Rightarrow v_x = 200 m/s$ because V_x is constant

$v_{xi} = v_i \cos\theta \Rightarrow 200 = v_i \cos 35^\circ = 0.82 v_i$

$v_i = \frac{200}{0.82} = 244\, m/s$

$v_{yi} = v_i \sin\theta = (244)\sin 35^\circ = (244)(0.57) = 139.1\, m/s$

b

2] $v_{yi} = v_i \sin\theta = (20)\sin 37^\circ = (20)(0.6) = 12\, m/s$

we can calculate the time to the highest point

$v_{yf} = v_{yi} + a_y t \Rightarrow 0 = 12 + (-10)(t)$

$12 = 10t \Rightarrow t = \frac{12}{10} = 1.2 \sec$

the total time $= (1.2)(2) = 2.4 \sec$ زمن الصعود + زمن الهبوط

e

3] $r = 2cm = 0.02m$, $f = 4\, rev/\sec$

$a_c = 4\pi^2 r f^2 = (4)(\pi^2)(0.02)(16) = 12.6\, m/s^2$

a

4] y-direction

$\Delta y = v_{yi} t + \frac{1}{2} a t^2 \Rightarrow 400 = (0)(t) + (\frac{1}{2})(9.8)(t^2)$

$400 = 4.9 t^2 \Rightarrow t^2 = \frac{400}{4.9} = 81.6$

$t = \sqrt{81.6} \approx 9 \sec$

x-direction

$\Delta x = v_{xi} t = (300)(9) = 2700m = 2.7km$

d

5] $v_f = \sqrt{(v_{xf})^2 + (v_{yf})^2}$

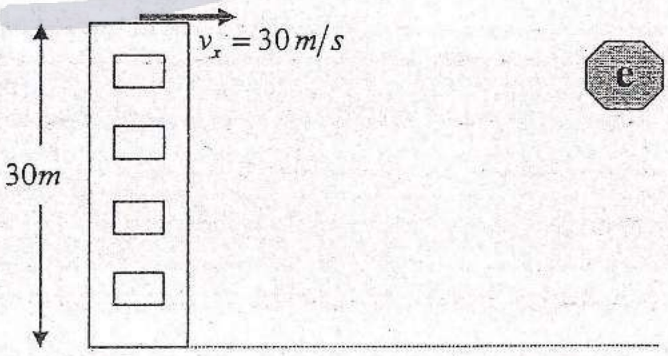
$v_{xf} = v_{xi} = 30\, m/s$

$v_{yf}^2 = v_{yi}^2 + 2a_y \Delta y$

$v_{yf}^2 = (0)^2 + (2)(9.8)(30) = 588$

$v_{yf} = \sqrt{588} = 24.2$

$v_f = \sqrt{(30)^2 + (24.2)^2} = \sqrt{1486} = 38.5\, m/s$



e

6] $a_r = 4\pi^2 r f^2 \Rightarrow 18 = (4)(\pi^2)(0.5) f^2$

$18 = 19.7 f^2 \Rightarrow f^2 = \frac{18}{19.5} = 0.91$

$f = \sqrt{0.91} = 0.95\, rev/\sec$

$f = (0.95)(60) = 57\, rev/\min$

a

7] $\bar{a} = \frac{v_f - v_i}{t_f - t_i} = \frac{(12i + 6j) - (4i - 6j)}{10 - 0} = \frac{8i + 12j}{10} = 0.8i + 1.2j$

c

8] x - direction

$x_i = 2 \quad , \quad v_{xi} = 1 \quad , \quad a_x = -1 \quad , \quad t = 2$

$\Delta x = v_{xi} t + \frac{1}{2} a_x t^2 = (1)(2) + (\frac{1}{2})(-1)(4) = 2 - 2 = 0$

$\Delta x = x_f - x_i \Rightarrow 0 = x_f - 2 \Rightarrow x_f = 2$

y - direction

$y_i = 1 \quad , \quad v_{yi} = -2 \quad , \quad a_y = 1 \quad , \quad t = 2$

$\Delta y = v_{yi} t + \frac{1}{2} a_y t^2 = (-2)(2) + (\frac{1}{2})(1)(4) = -4 + 2 = -2$

$\Delta y = y_f - y_i \Rightarrow -2 = y_f - 1 \Rightarrow y_f = -1$

$r_f = x_f i + y_f j = 2i - j$

$|r_f| = \sqrt{(2)^2 + (-1)^2} = \sqrt{4+1} = \sqrt{5} = 2.2m$

e

9] x - direction

$v_{xf} = v_{xi} + a_x t = (16) + (3)(2) = 16 + 6 = 22\, m/s$

y - direction

$v_{yf} = v_{yi} + a_y t = (-12) + (-6)(2) = -12 - 12 = -24\, m/s$

speed $= \sqrt{(22)^2 + (-24)^2} = \sqrt{1060} = 32.6\, m/s$

b

10] speed $= \sqrt{(v_x)^2 + (v_y)^2}$

at maximum height ($v_y = 0$)

$v_{xi} = v_{xf}$ (constant at all points)

$v_{xi} = v_i \cos\theta = (20)\cos 60^\circ = (20)(0.5) = 10\, m/s$

speed $= \sqrt{(10)^2 + (0)^2} = \sqrt{100} = 10\, m/s$

e

11] $v_{xi} = v_{xf}$ (constant at all points)

$v_{xi} = v_i \cos\theta = (1000)\cos 53^\circ$

$= (1000)(0.6) = 600\, m/s$

d

12] x - direction

$v_{xi} = 6\, m/s \quad , \quad a_x = 0 \quad , \quad t = 2s$

$\Delta x = v_{xi} t + \frac{1}{2} at^2 = (6)(2) + (\frac{1}{2})(0)(4) = 12m$

y - direction

$v_{yi} = 0 \quad , \quad a_y = 3\, m/s^2 \quad , \quad t = 2s$

$\Delta y = v_{yi} t + \frac{1}{2} a_y t^2 = (0)(2) + (\frac{1}{2})(3)(4) = 6m$

position vector $= 12i + 6j$

d

13] $a_c = \frac{v^2}{R} \quad , \quad \begin{Bmatrix} v \to 2v \\ R \to 3R \end{Bmatrix} \quad \Rightarrow \quad \frac{(2v)^2}{3R} = \frac{4v^2}{3R} = \frac{4}{3} a_c$

b

14] circumference $= 2\pi r$

$8 = (2)(\pi)(r) = 6.28r \quad \Rightarrow \quad r = \frac{8}{6.28} = 1.27m$

$a_r = 4\pi^2 r f^2 = (4)(\pi^2)(1.27)(25) = 1256\, m/s^2$

d

15] y - direction

$v_{yi} = 5\, m/s \quad , \quad a_y = -2\, m/s^2 \quad , \quad v_{yf} = 0$ (at maximum height)

$v_{yf}^2 = v_{yi}^2 + 2a_y \Delta y \quad \Rightarrow \quad 0 = (25) + (2)(-2)(\Delta y)$

$25 = 4\Delta y \quad \Rightarrow \quad \Delta y = \frac{25}{4} = 6.25m$

$v_{yf} = v_{yi} + a_y t \quad \Rightarrow \quad 0 = (5) + (-2)(t)$

$5 = 2t \quad \Rightarrow \quad t = \frac{5}{2} = 2.5s$

x - direction

$v_{xi} = 0 \quad , \quad a_x = 3\, m/s^2 \quad , \quad t = 2.5s$

$\Delta x = v_{xi} t + \frac{1}{2} a_x t^2 = (0)(2.5) + (\frac{1}{2})(3)(6.25) = 9.375m$

$|r| = \sqrt{(\Delta x)^2 + (\Delta y)^2} = \sqrt{(9.375)^2 + (6.25)^2} = \sqrt{127} = 11.3m$

d

16] x - direction

$v_{ix} = v_i \cos\theta = (60)(\cos 30) = 52 m/s$

$\Delta x = v_{ix} t \Rightarrow t = \frac{\Delta x}{v_{ix}} = \frac{80}{52} = 1.54 s$

y - direction

$v_{iy} = v_i \sin\theta = (60)(\sin 30) = 30 m/s$

$\Delta y = v_{iy} t + \frac{1}{2} a t^2 = (30)(1.54) + (\frac{1}{2})(-9.8)(1.54)^2 = 34.6 m$

a

17] $a_r = \frac{v^2}{r} = \frac{(6)^2}{2} = \frac{36}{2} = 18 m/s^2$

$\tan\theta = \frac{a_t}{a_r} \Rightarrow a_t = a_r \tan\theta$

$a_t = (18)\tan 60^\circ = (18)(1.73) = 31.2 m/s^2$

e

18] x - direction

$v_{ix} = v_\circ \cos\theta = v_\circ \cos 45 = 0.7 v_\circ$

$\Delta x = v_{ix} t \Rightarrow 20 = (0.7 v_\circ)(t)$

$t = \frac{20}{0.7 v_\circ}$ .... (1)

y - direction

$v_{iy} = v_\circ \sin\theta = v_\circ \sin 45 = 0.7 v_\circ$

$\Delta y = v_{iy} t + \frac{1}{2} a t^2 \Rightarrow 10 = (0.7 v_\circ)(\frac{20}{0.7 v_\circ}) + (\frac{1}{2})(-9.8)(\frac{20}{0.7 v_\circ})^2$

$10 = 20 - \frac{4000}{v_\circ^2} \Rightarrow v_\circ^2 = \frac{4000}{10} = 400$

$v_\circ = \sqrt{400} = 20 m/s$

e

Physics 101
Chapter 5

The Laws of Motion

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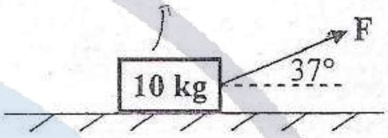
1]: Two forces in the xy-plane acting on 2 kg mass. The resulting Acceleration is (3i) $m.s^{-2}$. If F_1= (6i – 5j) N, then F_2 (N) is given by:
a) (2i – 5j) b) (5j) c) (2i) d) (2i +5j) e) (12i – 5j)

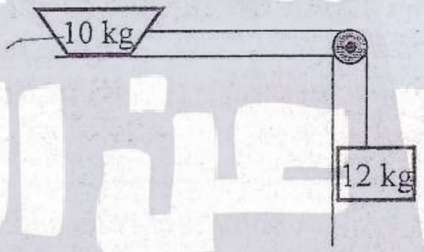
2]: A 10 kg mass is placed on rough horizontal surface of μ_k= 0.40 . The force (N) shown in this figure needed to pull the mass on the rough surface with constant speed is :



a) 42.6 b) 21.3 c) 70.0 d) 37.7 e) 28.8

3]: A person stands on a scale in an elevator. The maximum and minimum scale reading are 591 N and 391 N respectively. If the acceleration of the elevator is constant, then the weight (N) of the person is:
a) 50 b) 541 c) 100 d) 200 e) 491

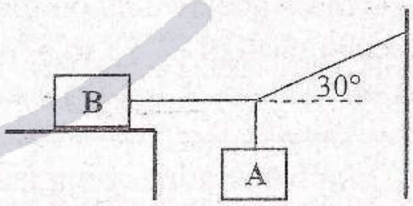
4]: A 10 kg crate is placed on a rough horizontal surface μ_k=0.4 and connected with 12 kg hanging mass via a string that passes over a massless and frictionless pully as shown in the figure beside. The mass (kg) that must be added to the crate so that the crate moves with constant velocity is:



a) 8.0 b) 10.0 c) 5.1 d) 20.0 e) 50.0

5]: A mass m is traveling at an initial speed v_i = 25.0 m/s. it is brought to rest in a distance of 62.5 m by a force of 15.0 N. The mass is:
a) 37.5 kg b) 3.00 kg c) 1.50 kg d) 6.00 kg e) 3.75 kg

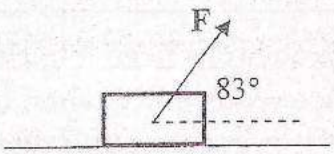
6]: Block B weights 711 N. The coefficient of static friction between the block and the horizontal surface is 0.25 . The maximum weight of block A for which the system will be stable in (N) is:



a) 205 b) 178 c) 103 d) 108 e) 355

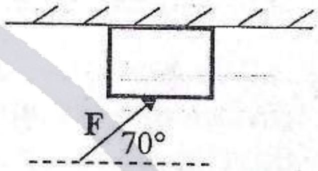
7]: A lamp hangs vertically from a cord in a descending elevator that accelerates at 2.4 m/s^2. If the tension in the cord is 89 N. The mass of the lamp in (kg) is:
a) 7.3 b) 12.0 c) 9.1 d) 10.0 e) 6.0

8]: The minimum force (N) that makes an angle of 83° with the horizontal, needed to lift 25 kg mass placed, as shown in the figure, on a horizontal plane surface is:



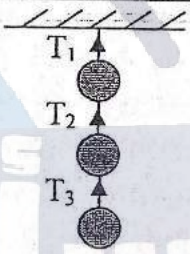
a) 147 b) 245 c) 18.0
d) 247 e) 148

9]: A force F of magnitude 80 N is used to push a 5.0 kg block across the ceiling of a room as shown. If the coefficient of kinetic friction between the block and the surface is 0.40. The magnitude of the acceleration of the block (in m/s^2) is:



a) 7.6 b) 7.2
c) 1.15 d) 3.4
e) none of the above

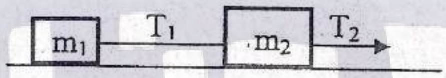
10]: Three 10 kg objects are suspended as shown.
The value of the tension force T_1 (in N) is:



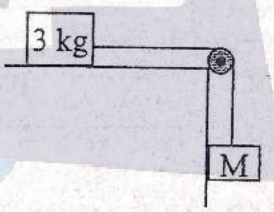
a) 196 b) 98 c) zero
d) 294 e) 9.8

11]: The two mass m_1, m_2 connected by a massless string are accelerated uniformly on a frictionless surface as shown. The ratio of the tensions T_2/T_1 is given by:

a) m_1/m_2 b) m_2/m_1
c) $(m_1 + m_2)/m_1$ d) $m_1/(m_1 + m_2)$
e) $m_2/(m_1 + m_2)$



12]: The system shown is released from rest and moves with an acceleration of 1 m/s^2. The value of M (in kg) is: (consider all the surfaces are frictionless)



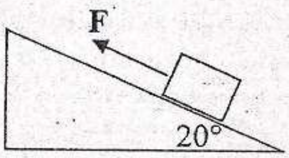
a) 0.42 b) 0.34 c) 0.50
d) 0.59 e) 0.68

13]: Two horizontal forces in the x-y plane, F_1 and F_2, are acting upon a 2 kg mass. The mass accelerates on the frictionless horizontal x-y plane surface with an acceleration of (2.5)i $m.s^{-2}$. Assuming that F_1= (5 N)i + (5 N)j, the force F_2 (N) is:

a) -9j b) -5j c) 9j d) 10i e) 5j

14]: A 3 kg block slides on a frictionless 20° incline plane. If a force of 19 N acting parallel to inclined is applied to the block, as shown in the figure, the acceleration ($m.s^{-2}$) of the along the plane is:

a) 3.0 downward b) 3.9 upward
c) 3.0 upward d) 2.0 upward
e) 2.0 downward



15]: A box is hung from a spring balance attached to the ceiling of an elevator. The balance reads 93 N when the elevator is accelerating upward and reads 54 N while it is accelerating downward with the same acceleration. The mass (kg) of the box is:

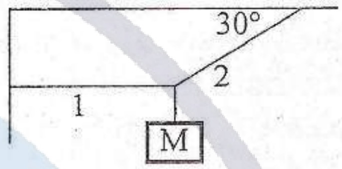
a) 5.0 b) 1.5 c) 15.0 d) 2.0 e) 7.5

16]: A force accelerates a body of mass M. The same force applied to a second body produces three times the acceleration. The mass of the second body will be:

a) M b) 3M c) M/3 d) 9M e) M/9

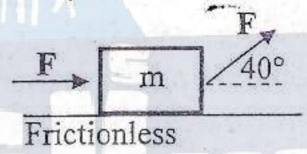
17]: If M = 2.0 kg, what is the tension in string 1 shown?

a) 1.2 N b) 34 N
c) 40 N d) 3.5 N
e) 11 N



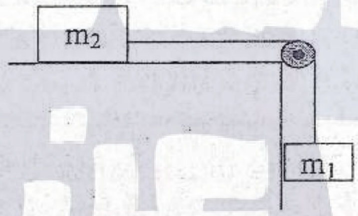
18]: If F = 4.0 N and m = 2.0 kg, what is the magnitude of the acceleration for the block shown?

a) 5.3 m/s^2 b) 4.4 m/s^2 c) 8.4 m/s^2
d) 6.2 m/s^2 e) 3.5 m/s^2



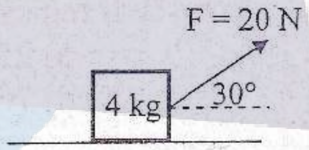
19]: In the figure shown, all surfaces are frictionless. The masses m_1= 6 kg, m_2= 2 kg and the system is released from rest. The speed (in m/s) of m_2 after 3 seconds is:

a) 2.5 b) 10 c) 0
d) 7.4 e) 3



20]: A 4 kg box is pulled across a rough surface at constant speed by a force F= 20 N that makes an angle of 30° with the horizontal as shown. The value of the coefficient of kinetic friction μ_k is:

a) 0.34 b) 0.58 c) 0.44
d) 0.31 e) 0.22

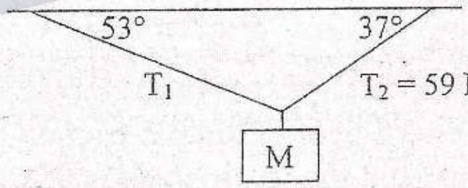


21]: The apparent (effective) weight (in N) of a 70 kg man standing in an elevator that is moving downward and decelerating at 4 m/s^2 is:

a) 420 b) 700 c) 966 d) 900 e) 1050

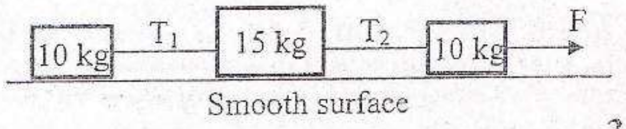
22]: If mass M is in equilibrium, then the tension T_1 (in Newton) is:

a) 49 b) 78
c) 59 d) 85
e) 62

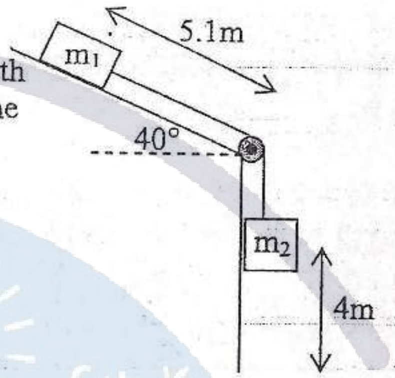


23]: If the acceleration of the system is 10 m/s^2.
Then the magnitude of T_1 (in Newton) is:

a) 100 b) 300 c) 150
d) 250 e) 200



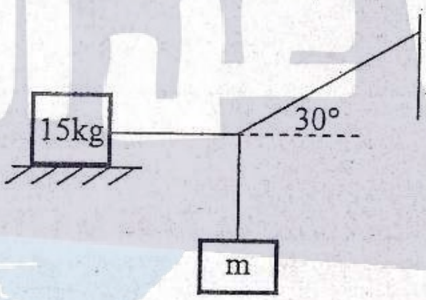
24]: Two blocks m_1= 0.2 kg and m_2= 0.5 kg are connected by a massless string as shown in the figure. If the system is released from rest, then the speed (in m/s) with which m_2 will hit the floor is:



a) 6.1 b) 5.6 c) 3.6
d) 4.8 e) 8.4

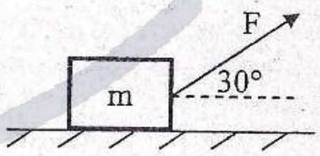
25]: A body moves with constant speed in a straight line. Which of the following statements must be true?
a) No force acts on the body.
b) A single constant force acts on the body in the direction of motion.
c) A single constant force acts on the body in the opposite to the motion.
d) A net force of zero acts on the body.
e) A constant net force acts on the body in the direction of motion.

26]: A 15 kg block is placed on a rough horizontal surface of μ_s= 0.3 .The block is kept in equilibrium as shown in the figure. The maximum hanging mass for which the system will remain in equilibrium is:



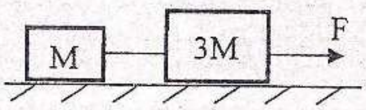
a) 2.6 b) 25.5
c) 42.1 d) 76.4
e) 4.3

27]: A 10 kg block is placed on a rough horizontal surface of μ_s= 0.5 and μ_k= 0.4 . The block is pulled by a 50 N force making an angle of 30° above the horizontal, as shown in the figure. The friction force (N) between the block and the surface is:



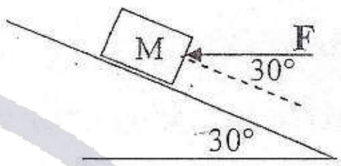
a) 21.0 b) 29.2 c) 14.6
d) 21.4 e) 28.7

28]: The coefficient of kinetic friction between the horizontal surface and the large block is 0.20 , and the coefficient of kinetic friction between this surface and the smaller block is 0.30 . If F= 16.8 N and M= 1.0 kg , the magnitude of the acceleration of either block is:



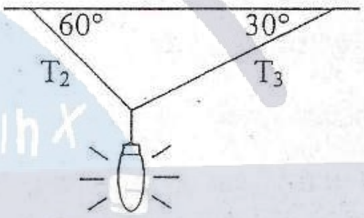
a) 2.0 b) 3.5 c) 1.5
d) 1.8 e) 1.3

29]: A block is pushed up a frictionless 30° incline by an applied force as shown. If $F = 25$ N and $M = 3.0$ kg, the normal reaction force on the block is:



a) 15.0 N b) 38.5 N c) 26.0 N
d) 27.5 N e) 30.0 N

30]: A lamp of mass m is suspended from the ceiling by two cords as shown. The ratio of the magnitude of the vertical component of the tension in T_2 to that in T_3 is:



a) 1:1 b) 1:2 c) $\sqrt{3}:3$
d) 3:2 e) 3:1

31]: A 40 kg object supported by a vertical rope is initially at rest. Then it starts accelerating upward and reaches a velocity of 3.5 m/s in 0.7 sec. the tension In the rope during acceleration (in N) is:

a) 592 b) 198 c) 396 d) 150 e) zero

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Chapter 5
The Laws of Motion

1] $\Sigma f = ma \Rightarrow f_1 + f_2 = ma$

$(6i - 5j) + f_2 = (2)(3i) \Rightarrow (6i - 5j) + f_2 = 6i$

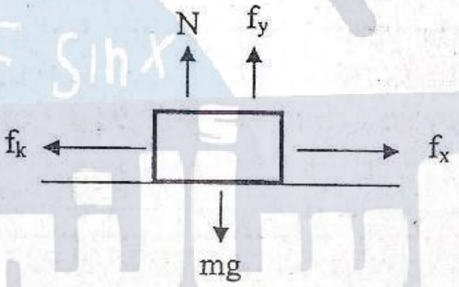
$\therefore f_2 = 5j$

b

2] $f_x = f \cos 37 = 0.8f$

$f_y = f \sin 37 = 0.6f$

constant speed $\Rightarrow a = 0 \Rightarrow \Sigma f = 0$



$(\Sigma f = 0)_x \Rightarrow f_x = f_k \Rightarrow 0.8f = (0.4)N$

$N = \dfrac{0.8f}{0.4} \Rightarrow N = 2f \; \ldots\ldots (1)$

$(\Sigma f = 0)_y \Rightarrow f_y + N = mg \Rightarrow 0.6f + N = (10)(9.8) = 98$

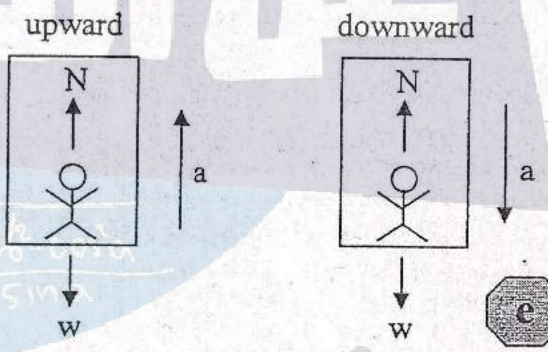
$0.6f = 98 - N \Rightarrow 0.6f = 98 - 2f$

$2.6f = 98 \Rightarrow f = \dfrac{98}{2.6} = 37.3$

d

3] upward: $N_{max} - w = ma \; \ldots\ldots (1)$

downward: $w - N_{min} = ma \; \ldots\ldots (2)$



(1) - (2) $\Rightarrow [N_{max} - (-N_{min})] + [-w - w] = 0$

$591 + 391 = 2w \Rightarrow 982 = 2w$

$w = \dfrac{982}{2} = 491$

e

4] constant speed $\Rightarrow a = 0 \Rightarrow \Sigma f = 0$

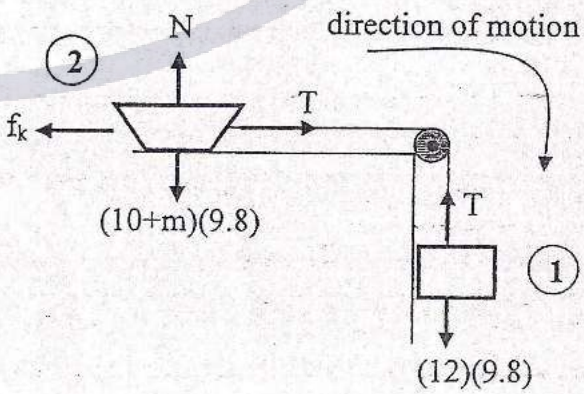
first mass: $\Sigma f = 0 \Rightarrow m_1 g - T = 0$

$(12)(9.8) - T = 0 \Rightarrow T = 117.6 \; \ldots\ldots (1)$

second mass: $\Sigma f = 0 \Rightarrow T - f_k = 0$

$T - \mu_k N = 0 \Rightarrow 117.6 - (0.4)[(10 + m)(9.8)]$

$117.6 = 39.2 + 3.92m \Rightarrow m = \dfrac{78.4}{3.92} = 20kg$



d

5] $v_f^2 = v_i^2 + 2a\Delta x \Rightarrow 0 = (25)^2 + (2)(a)(62.5)$

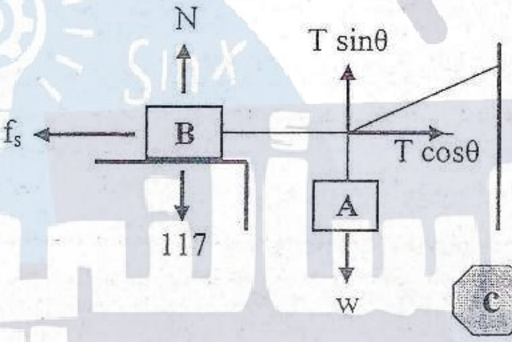
$625 = -125a \Rightarrow a = -\frac{625}{125} = -5m/s^2$ (the negative sign means deceleration)

$\Sigma f = ma \Rightarrow 15 = 5m$

$m = 3kg$

b

6] $\Sigma f_x = 0 \Rightarrow T\cos\theta = f_s = \mu_s N$



$(T)(\cos 30) = (0.25)(711) \Rightarrow 0.87T = 177.75$

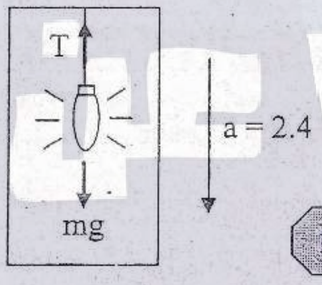
$T = \frac{177.75}{0.87} = 204.3$

$\Sigma f_y = 0 \Rightarrow w = T\sin\theta$

$w = (204.3)(\sin 30) = (204.3)(0.5) = 102.2N$

c

7] $\Sigma f = ma \Rightarrow mg - T = ma$



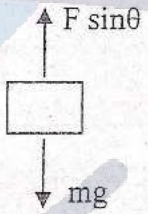
$(m)(9.8) - T = 89 = (m)(2.4)$

$(9.8 - 2.4)(m) = 89 \Rightarrow 7.4m = 89$

$m = \frac{89}{7.4} = 12kg$

b

8] $\Sigma f_y = 0 \Rightarrow f\sin\theta = mg$



$(f)(\sin 83) = (25)(9.8)$

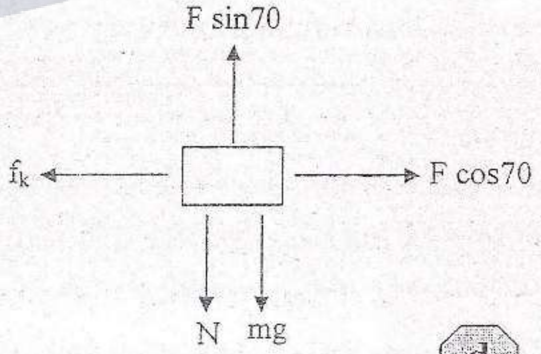
$f = \frac{(25)(9.8)}{(\sin 83)} = 247N$

d

9] $\Sigma f_y = 0 \Rightarrow F\sin\theta = mg + N$

$(80)(\sin 70) = (5)(9.8) + N \Rightarrow 75.2 = 49 + N$

$N = 26.2$ .... (1)



$\Sigma f_x = ma \Rightarrow F\cos\theta - f_k = ma$

$(80)(\cos 70) - (0.4)(26.2) = 5a \Rightarrow 16.88 = 5a$

$a = \frac{16.88}{5} = 3.38m/s^2$

d

10] $T_1 = m_1 g + m_2 g + m_3 g = (10+10+10)(9.8)$

$T_1 = 294N$

d

11] first mass: $\Sigma f = ma \Rightarrow T_1 = m_1 a \ldots\ldots (1)$

second mass: $\Sigma f = ma \Rightarrow T_2 - T_1 = m_2 a$

$T_2 - m_1 a = m_2 a \Rightarrow T_2 = m_2 a + m_1 a \ldots\ldots (2)$

$\frac{T_2}{T_1} = \frac{(m_1 + m_2)a}{m_1 a} = \frac{m_1 + m_2}{m_1}$

c

12] first mass: $\Sigma f = m_1 a$

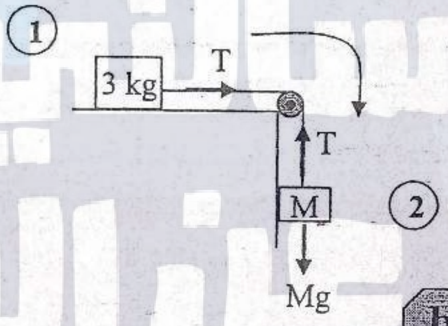
$T = ma = (3)(1) = 3$

second mass: $\Sigma f = m_2 a$

$Mg - T = Ma \Rightarrow M(9.8) - 3 = M(1)$

$(908-1)M = 3 \Rightarrow 8.8M = 3$

$M = \frac{3}{8.8} = 0.34kg$



b

13] $\Sigma f = ma \Rightarrow f_1 + f_2 = ma$

$(5i + 5j) + f_2 = (2)(2.5i)$

$(5i + 5j) + f_2 = 5i \Rightarrow f_2 = -5j$

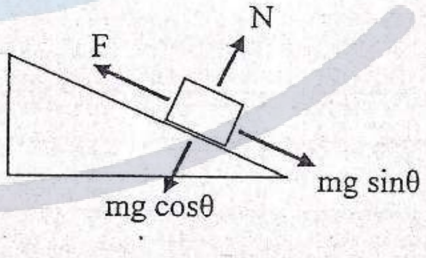
b

14] $\Sigma f = ma \Rightarrow F - mg \sin\theta = ma$

$19 - (3)(9.8)(\sin 20) = (3)a$

$19 - 10 = 3a \Rightarrow 9 = 3a$

$a = \frac{9}{3} = 3m/s^2$ (upward)



c

15] upward: $T - mg = ma$

$93 - (9.8)m = ma \ldots\ldots (1)$

downward: $mg - T = ma$

$(9.8)m - 54 = ma \ldots\ldots (2)$

(1) - (2) $\Rightarrow [(93 - (-54)] + [(-9.8m) - (9.8m)] = ma - ma$

$147 - 19.6m = 0 \Rightarrow m = \frac{147}{19.6} = 7.5kg$

e

16] $F_1 = M_1 a_1 \qquad F_2 = M_2 a_2$

$F_1 = F_2 \;\Rightarrow\; M_1 a_1 = M_2 a_2$

$a_2 = 3a_1 \;\Rightarrow\; M_1 a_1 = M_2 (3a_1)$

$M_2 = \dfrac{M_1}{3}$

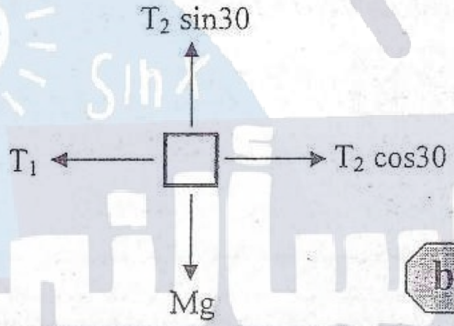
c

17] $\Sigma f_y = 0 \;\Rightarrow\; Mg = T_2 \sin\theta$

$(2)(9.8) = T_2 \sin 30 \;\Rightarrow\; T_2 = \dfrac{19.6}{\sin 30} = 39.2$

$\Sigma f_x = 0 \;\Rightarrow\; T_1 = T_2 \cos\theta$

$T_1 = (39.2)(\cos 30) = 34$



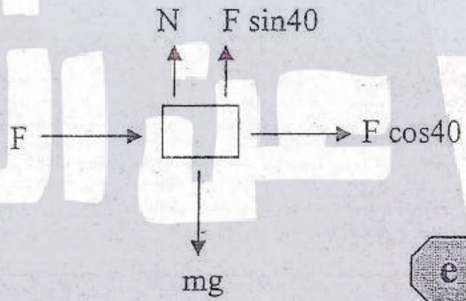
b

18] $\Sigma f_y = 0$

$\Sigma f_x = ma_x \;\Rightarrow\; F + F\cos\theta = ma$

$4 + (4)(\cos 40) = (2)(a) \;\Rightarrow\; 7 = 2a$

$a = \dfrac{7}{2} = 3.5 m/s^2$



e

19] first mass: $\Sigma f = m_1 a$

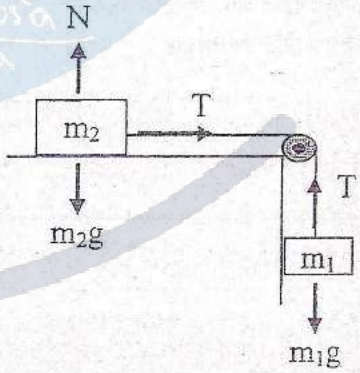
$T = (6)(a) \;\Rightarrow\; T = 6a \ldots\ldots (1)$

second mass: $\Sigma f = m_2 a$

$mg - T = ma \;\Rightarrow\; (2)(9.8) - 6a = 2a$

$8a = 19.6 \;\Rightarrow\; a = \dfrac{19.6}{8} = 2.45 m/s^2$

$v_f = v_i + at \;\Rightarrow\; v_f = 0 + (2.45)(3) = 7.35 m/s$



d

20] $\Sigma f_y = 0 \Rightarrow mg = F\sin\theta + N$

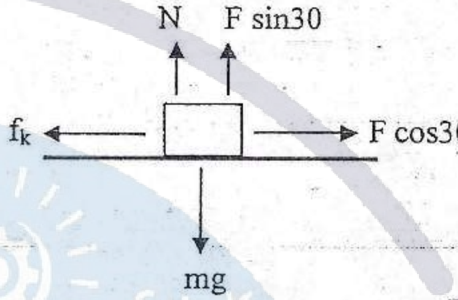
$(4)(9.8) = (20)(\sin 30) + N \Rightarrow 39.2 = 10 + N$

$N = 39.2 - 10 = 29.2$ ...... (1)

$\Sigma f_x = 0 \Rightarrow F\cos\theta = \mu_k N$

$(20)(\cos 30) = (\mu_k)(29.2) \Rightarrow 17.3 = 29.2\mu_k$

$\mu_k = \frac{17.3}{29.2} = 0.59$

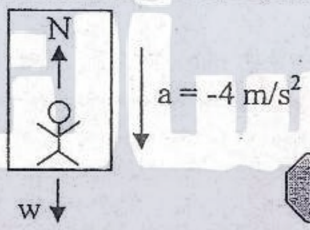


b

21] $\Sigma f = ma \Rightarrow mg - N = ma$

$(70)(9.8) - N = (70)(-4)$

$686 - N = -280 \Rightarrow N = 686 + 280 = 966$

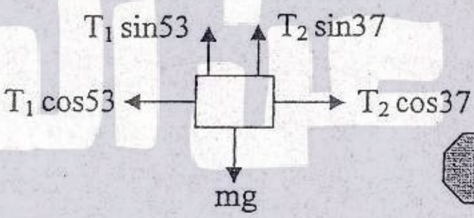


c

22] $\Sigma f_x = 0$

$T_1 \cos 53 = T_2 \cos 37$

$T_1 = \frac{T_2 \cos 37}{\cos 53} = \frac{(59)(0.8)}{0.6} = 78$



b

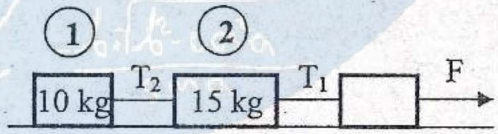
23] first mass: $\Sigma f = m_1 a$

$T_2 = ma = (10)(10) = 100$

second mass: $\Sigma f = m_2 a$

$T_1 - T_2 = ma \Rightarrow T_1 - 100 = (15)(10)$

$T_1 = 100 + 150 = 250$



d

24] first mass: $\Sigma f = ma \Rightarrow mg - T = ma$

$(0.5)(9.8) - T = (0.5)(a) \Rightarrow 4.9 - T = 0.5a$ ...... (1)

second mass: $\Sigma f = ma \Rightarrow mg\sin\theta + T = ma$

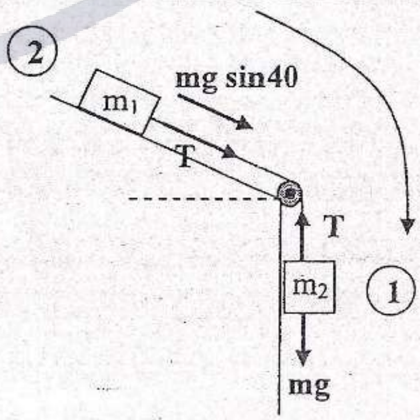
$(0.2)(9.8)(\sin 40) + T = (0.2)(a) \Rightarrow 1.26 + T = 0.2a$ ..... (2)

$(1) + (2) \Rightarrow 6.06 = 0.7a$

$a = \frac{6.16}{0.7} = 8.8 m/s^2$

$v_f^2 = v_i^2 + 2a\Delta y \Rightarrow v_f^2 = 0 + (2)(8.8)(4) = 70.4$

$v_f = \sqrt{70.4} = 8.4 m/s$

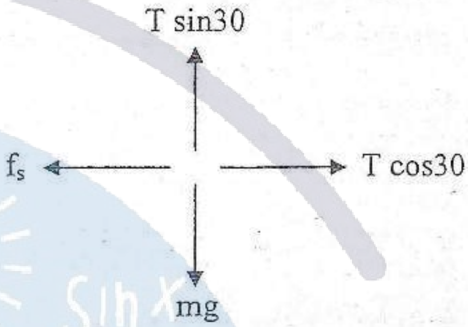


e

25] A net force of zero acts on the body

d

26] $\Sigma f_x = 0 \Rightarrow f_s = T\cos\theta$



$\mu_s N = T\cos 30 \Rightarrow (0.3)(15)(9.8) = T\cos 30$

$T = \dfrac{44.1}{\cos 30} = 51 \;\ldots\ldots (1)$

$\Sigma f_y = 0 \Rightarrow T\sin\theta = mg$

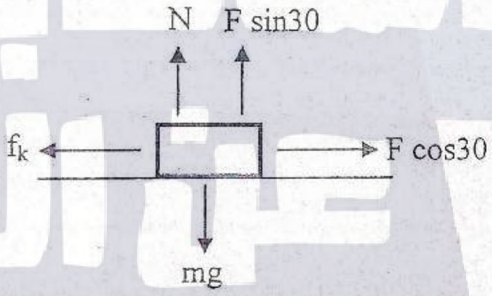
$(51)(\sin 30) = (m)(9.8)$

$m = \dfrac{(51)(\sin 30)}{9.8} = 2.6kg$

a

27] $F_x = F\cos\theta = (50)(\cos 30) = 43.3$

$F_y = F\sin\theta = (50)(\sin 30) = 25$



$\Sigma f_y = 0 \Rightarrow mg = F\sin\theta + N$

$(10)(9.8) = 25 + N \Rightarrow N = 98 - 25 = 73$

$\begin{cases} f_s = \mu_s N = (0.5)(73) = 36.5 \\ f_k = \mu_k N = (0.4)(73) = 29.2 \end{cases}$

we note that the x-component of the external force (43.3) is larger than the force of static friction (36.5), so the block is not stable.

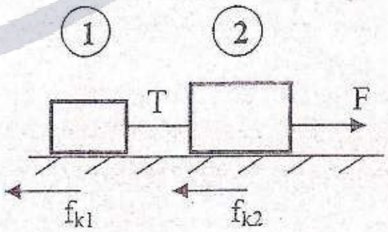
$f_k = 29.2$

b

28] first mass: $\Sigma f = ma$

$T - \mu_{k1}N = m_1 a \Rightarrow T - (0.3)(1)(9.8) = (1)a$

$T - 2.94 = a \;\ldots\ldots (1)$



second mass: $\Sigma f = ma$

$F - T - \mu_{k2}N = m_2 a$

$16.8 - T - (0.2)(3)(9.8) = (3)a \Rightarrow 16.8 - T - 5.88 = 3a$

$10.92 - T = 3a \;\ldots\ldots (2)$

$(1) + (2) \Rightarrow 7.98 = 4a \Rightarrow a = \dfrac{7.98}{4} = 2m/s^2$

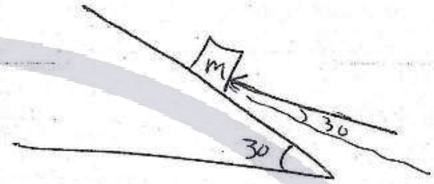
a

29] $(\Sigma f)_{\perp} = 0$

$F\sin\theta + mg\cos\theta = N$

$(25)(\sin 30) + (3)(9.8)(\cos 30) = N$

$12.5 + 25.5 = N \Rightarrow N = 38$

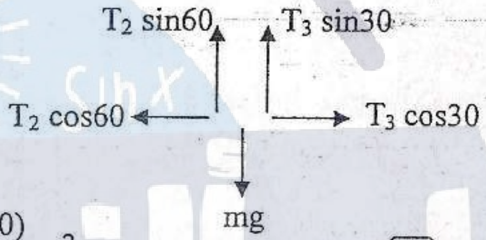


b

30] $\Sigma f_x = 0 \Rightarrow T_2 \cos 60 = T_3 \cos 30$

$T_2 = \dfrac{T_3 \cos 30}{\cos 60}$ . . . . . . (1)

$(T_2)_{\perp} : (T_3)_{\perp} \Rightarrow \dfrac{T_2 \sin 60}{T_3 \sin 30} = \dfrac{\left(\dfrac{T_3 \cos 30}{\cos 60}\right)\sin 60}{T_3 \sin 30} = \dfrac{(\cos 30)(\sin 60)}{(\cos 60)(\sin 30)} = 3$



e

31] $v_f = v_i + at \Rightarrow 3.5 = 0 + (a)(0.7)$

$a = \dfrac{3.5}{0.7} = 5 m/s^2$

$\Sigma f = ma \Rightarrow T - mg = ma$

$T - (40)(9.8) = (40)(5) \Rightarrow T - 392 = 200$

$T = 200 + 392 = 592$

a

Physics 101
Chapter 6

Circular Motion and Other Applications of Newton's Laws

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Chapter 6
Circular Motion

1]: A 0.5 kg mass attached to the end of a string swings a vertical circle of radius 2.0 m. When the mass is at the lowest point on the circle, the speed of the mass is 12 m/s. The magnitude of the force (in N) of the string on the mass at this position is approximately:

a) 31 b) 36 c) 41 d) 46 e) 23

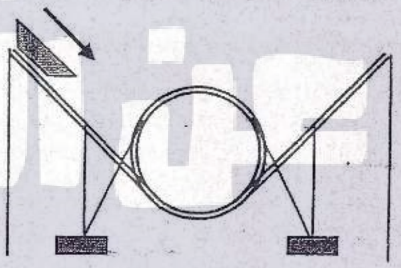
2]: A roller-coaster car has a mass of 500 kg when fully loaded with passengers. The car passes over a hill of radius 15 m. At the top of the hill, when the car has a speed of 8.0 m/s, the force (in kN) of the track is:

a) 7.0 up b) 7.0 down c) 2.8 down d) 2.8 up e) 5.6 down

3]: A 750 kg car travels at 90 km/h around a curve with radius of 160 m. The banking angle of the curve, so that the car make the turn successfully is:

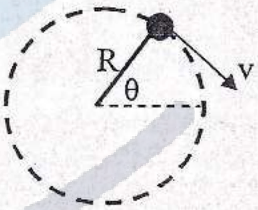
a) 21.7° b) 9° c) 20.6° d) 25° e) 15°

4]: The radius of a curvature of a loop - the - loop roller coaster is 12.0 m. At the top of the loop, the force that the seat exert on a passenger of mass m is 0.4 mg. The speed of the roller coaster at the top of the loop in (m/s) is:



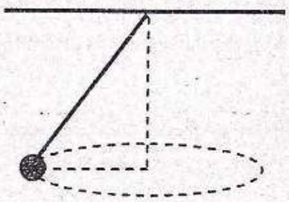
a) 9.1 b) 13.9 c) 3.1
d) 14.4 e) 12.8

5]: An object attached to the end of a string swings in a vertical circle of radius 1.2 m, as shown in the figure. At an instant when $\theta = 30^{\circ}$, the speed of the object is 6 m/s and the tension in the string is 38 N. The mass (kg) of the object is:



a) 2.0 b) 1.5 c) 1.8
d) 1.3 e) 0.80

6]: A conical pendulum is formed by attaching a small ball to a 1.2 m string. The ball swings with uniform velocity around a horizontal circle of radius 30 cm as shown in the figure. The velocity ($m.s^{-1}$) of the ball is:



a) 11.5 b) 0.72 c) 0.87
d) 3.4 e) 0.52

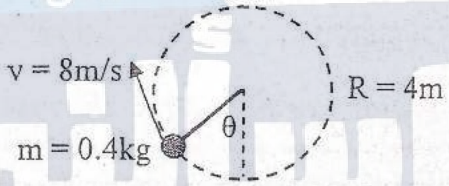
7]: A ball of mass m = 0.5 kg is moving in a vertical circle at the end of a string with constant speed of 2.5 m/s. If the radius r = 20 cm, then the tension in the string at the highest point (in N) is:

a) 15.4 b) 20.6 c) 10.6 d) zero e) 12.7

8]: A 1500 kg car is to go round a horizontal circular path of radius 10 m. If the coefficient of static friction is 0.3, the maximum speed (in m/s) at which the car can round the path without slipping is:

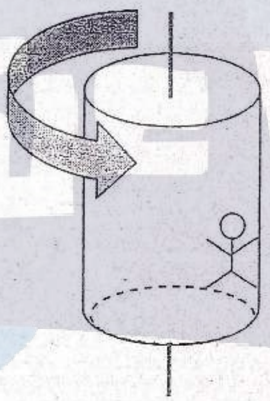
a) 6.7 b) 50.2 c) 5.5 d) 9.3 e) 21.3

9]: If a ball swings in a vertical circle as shown in the figure, then the tension (in Newton) in the string when $\theta = 23^\circ$ is:



a) 6.5 b) 10 c) 9.0
d) 7.5 e) 12

10]: An amusement park ride of a large vertical cylinder (radius 4 m) that spins about its axis fast enough that any person (50 kg) inside is held up against the walls when the floor drops away, see figure. If the coefficient of friction between the person and the wall is 0.4, the maximum period of revolution necessary to keep the person from falling is then:



a) 10.0 s b) 2.51 s c) 2.81 s
d) 6.32 s e) 7.90 s

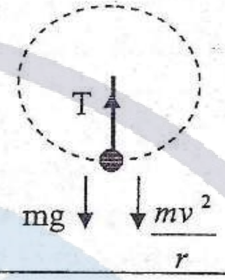
11]: A child places a picnic basket on the outer rim of a – merry – go round that has a radius of 4.6 m and revolves once every 30 s. The coefficient of static friction between the basket and the merry – go – round for the basket to stay on the ride is:

a) 0.097 b) 0.084 c) 0.021 d) 0.003 e) 0.042

1] $T = mg + \frac{mv^2}{r}$

$T = (0.5)(9.8) + \frac{(0.5)(12)^2}{2}$

$T = 4.9 + 36 = 40.9$

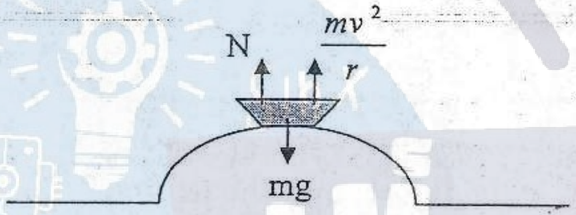


(c)

2] $\frac{mv^2}{r} + N = mg \Rightarrow N = mg - \frac{mv^2}{r}$

$N = (500)(9.8) - \frac{(500)(8)^2}{15} = 4900 - 2133$

$N = 2766\ newton = 2.766\ kilo\ newton\ up$



(d)

3] $N \sin\theta = \frac{mv^2}{r}$ . . . . . (1)

$N \cos\theta = mg$ . . . . . (2)

$(1)/(2) \Rightarrow \tan\theta = \frac{v^2}{rg}$

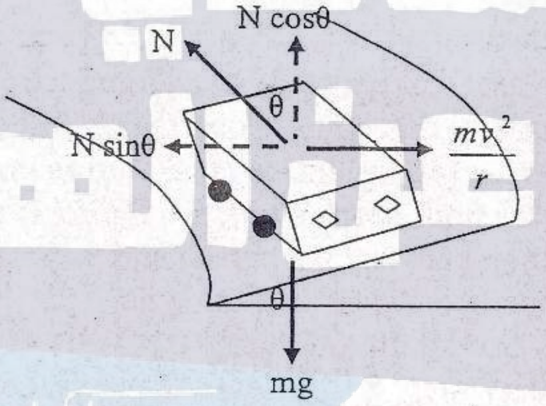
$\tan\theta = \frac{(25)^2}{(160)(9.8)} = 0.4$

$\theta = \tan^{-1}(0.4) = 21.7^o$

$V = \sqrt{\tan\theta\, Rg}$

$\tan\theta = \frac{V^2}{Rg}$

$\theta = \tan^{-1} \frac{V^2}{Rg}$



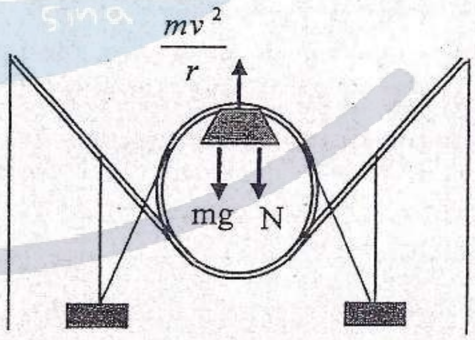
(a)

4] $\frac{mv^2}{r} = N + mg \Rightarrow \frac{mv^2}{r} = 0.4mg + mg$

$\frac{mv^2}{r} = 1.4mg \Rightarrow v^2 = \frac{1.4mgr}{m} = 1.4gr$

$v^2 = (1.4)(9.8)(12) = 164.64$

$v = \sqrt{164.64} = 12.8 m/s$



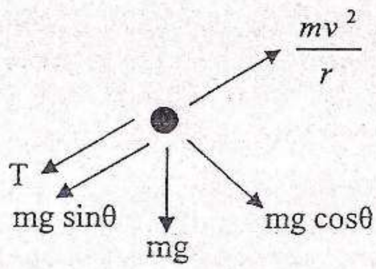
(e)

5] $T + mg\sin\theta = \frac{mv^2}{r} \Rightarrow T = \frac{mv^2}{r} - mg\sin\theta$

$T = m(\frac{v^2}{r} - g\sin\theta)$

$38 = m(\frac{36}{1.2} - (9.8)(\sin 30)) \Rightarrow 38 = m(30 - 4.9)$

$38 = m(25.1) \Rightarrow m = \frac{38}{25.1} = 1.5kg$



(b)

6] we must find θ

$$\cos\theta = \frac{r}{L} = \frac{0.3}{1.2} = 0.25$$

$$\theta = \cos^{-1}(0.25) = 75.5$$

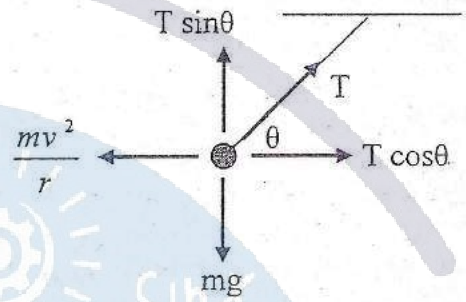
$$\Sigma f_y = 0 \;\Rightarrow\; T\sin\theta = mg \;\ldots\ldots(1)$$

$$\Sigma f_x = 0 \;\Rightarrow\; T\cos\theta = \frac{mv^2}{r} \;\ldots\ldots(2)$$

$$(1)/(2) \;\Rightarrow\; \tan\theta = \frac{rg}{v^2}$$

$$v^2 = \frac{rg}{\tan\theta} \;\Rightarrow\; v^2 = \frac{(0.3)(9.8)}{\tan 75.5} = 0.76$$

$$v = \sqrt{0.76} = 0.87 m/s$$

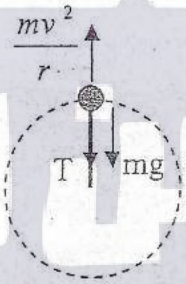


c

7] $$T + mg = \frac{mv^2}{r} \;\Rightarrow\; T = \frac{mv^2}{r} - mg$$

$$T = \frac{(0.5)(2.5)^2}{0.2} - (0.5)(9.8)$$

$$T = 15.6 - 4.9 = 10.7$$



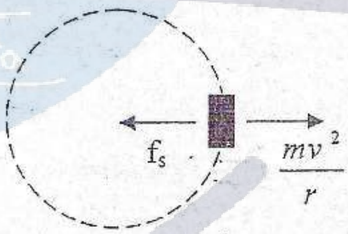
c

8] $$\frac{mv^2}{r} = f_s = \mu_s N$$

$$\frac{(1500)(v^2)}{10} = (0.3)(1500)(9.8)$$

$$150v^2 = 4410 \;\Rightarrow\; v^2 = \frac{4410}{150} = 29.4$$

$$v = \sqrt{29.4} = 5.4 m/s$$

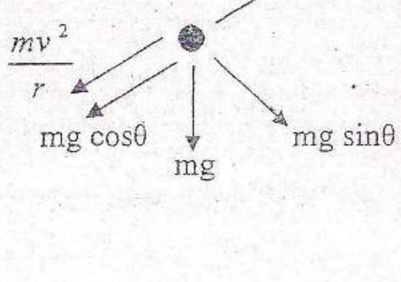


c

9] $$T = mg\cos\theta + \frac{mv^2}{r}$$

$$T = (0.4)(9.8)(\cos 23) + \frac{(0.4)(8)^2}{4}$$

$$T = 3.6 + 6.4 = 10$$



b

10] $mg = f_s = \mu_s N$

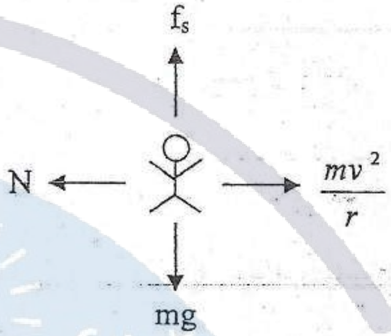
$$N = \frac{mg}{\mu_s} = \frac{(50)(9.8)}{0.4} = 1225$$

$$\frac{mv^2}{r} = N \Rightarrow v^2 = \frac{Nr}{m} = \frac{(1225)(4)}{50} = 98$$

$$v = \sqrt{98} = 9.9$$

$$v = r\omega \Rightarrow \omega = \frac{v}{r} = \frac{9.9}{4} = 2.47$$

$$\tau = \frac{2\pi}{\omega} = \frac{(2)(3.14)}{2.47} = 2.5\,\text{sec}$$



b

11] $\omega = \frac{2\pi}{\tau} = \frac{(2)(3.14)}{30} = 0.21$

$$v = r\omega = (4.6)(.21) = 0.963$$

$$\mu_s N = \frac{mv^2}{r} \Rightarrow \mu_s = \frac{mv^2}{rN} = \frac{mv^2}{rmg}$$

$$\mu_s = \frac{(0.963)^2}{(4.6)(9.8)} = 0.02$$

c

Physics 101

Chapter 7
Work and Kinetic Energy

+

Chapter 8
Potential Energy and Conservation of Energy

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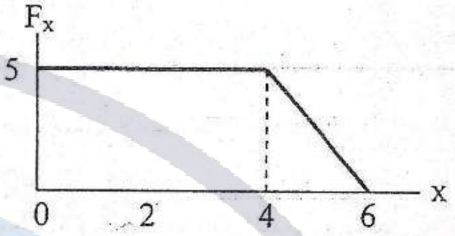
1]: The work (in J) done by the varying force shown in the figure from x = 0 to x = 6m, on an object that weighs 4 kg is:



a) 20 b) 30 c) 25
d) 35 e) 40

2]: The power output (in W) needed from a motor to lift, without friction, a mass of 1.5×10^4 kg, 25 m in 6.0 s at constant speed?

a) 2.0×10^6 b) 8.3×10^5 c) 3.1×10^5 d) 6.1×10^5 e) 2.2×10^4

3]: A 2 kg object strikes a spring (k = 400 N/m) and comes to rest after compressing the spring 0.69 m. The spring is sitting on rough – horizontal floor ($\mu_k = 0.4$). What was the initial velocity (m/s) of the object?

a) 30 b) 25 c) 10 d) 15 e) 5

4]: The power developed by a certain engine is a function of time according to $P = 2 + 2t + 3t^2$, where the units are SI. The work done by the engine in the interval from t = 0 to t = 2 s is:

a) 14 b) 10 c) 9 d) 18 e) 16

5]: A 6.0 kg block slides from point A down frictionless curve to point B, a friction force opposes the motion of the block so that it comes to a stop 2.5 m from B. The block's speed at B (in m/s) is:

a) 3.4 b) 2.4 c) 5.4
d) 6.4 e) 4.4

6]: In the question above, calculate the coefficient of kinetic friction between the block and the surface after position B:

a) 0.40 b) 0.30 c) 0.20
d) 0.60 e) 0.50

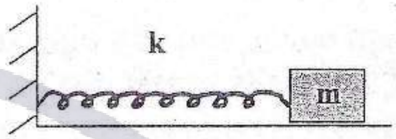
7]: The resultant force acting on 2.0 kg object is (3i + 4j) N, what is the change in kinetic energy (in J) as the object moves from (7i – 8j) m to (11i – 5j) m?

a) +28 b) +36 c) +32 d) +60 e) +24

8]: A 12 kg projectile is launched with an initial vertical speed of 20 m/s. It rises to a maximum height of 18 m above the launch point. How much work (in kJ) is done by the dissipative (air) resistive force on the projectile?

a) -0.40 b) -0.64 c) -0.28 d) -0.52 e) -0.76

9]: A 2 kg object fixed to the end of an ideal spring of spring constant (k = 200 N/m) as shown. If the object is pulled out 0.5 m and then released from rest, then its speed (m/s) as it passes the equilibrium point is:

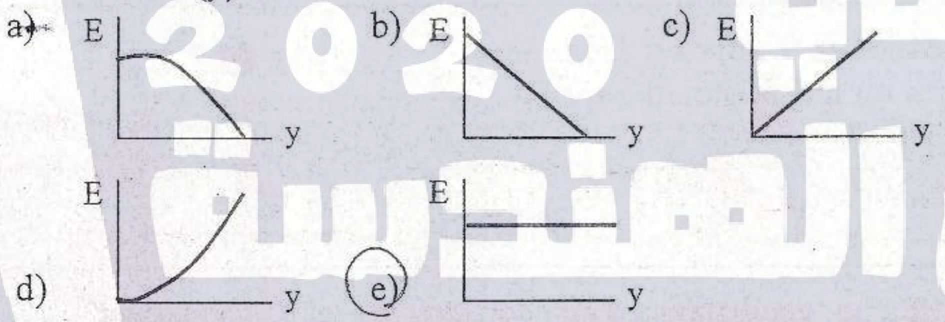


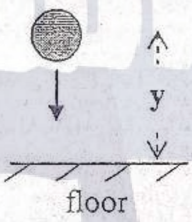
a) 0.5 b) 5 c) 10 d) 25 e) zero

10]: A 50 N force acts on 2 kg object initially at rest. When the force has been acting for 2 seconds, the power (W) at which it is delivered:

a) 2500 b) 1000 c) 100 d) 75 e) zero

11]: A ball is held at height (y) above a floor. It is then released and falls freely to the floor. The total mechanical energy (E) of the ball as a function of (y) is:

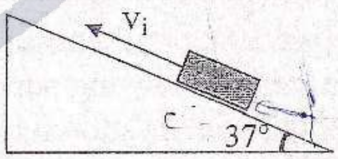




12]: Initially a body moves in one direction and has kinetic energy K. Then it moves in the opposite direction with three times its initial speed. Its kinetic energy becomes:

a) K b) 3K c) -3K d) 9K e) -9K

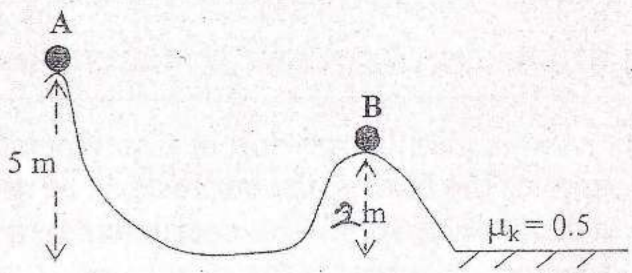
13]: A 2.4 kg box has an initial velocity of 3.8 m/s upward along a rough inclined at 37° to the horizontal. The coefficient of kinetic friction between the box and the plane is 0.30 . The distance the box can travel along the plane (in m) is:



a) 0.74 b) 0.53 c) 0.88
d) 2.03 e) 1.23

14]: The particle speed (in m/s) at B is:

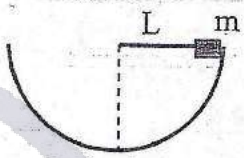
a) 10 b) 7.75 c) 5.48
d) 3.5 e) 9.2



15]: The distance traveled by the mass (m) on the frictional surface before coming to rest is:

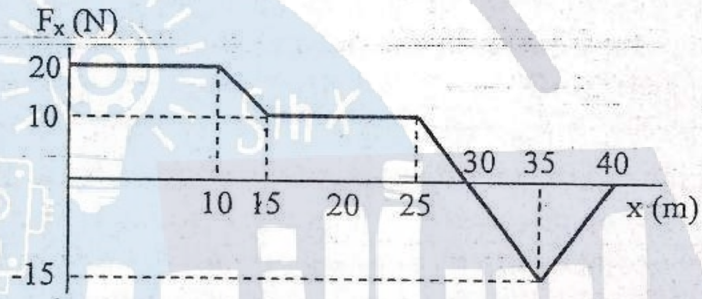
a) 10 b) 8 c) 6
d) 4 e) 2

16]: A ball on the end of a light string of length 0.5 m. If the ball is initially at rest, then it will fall along a circular arc as shown. The speed (m/s) of the ball at the lowest point is:



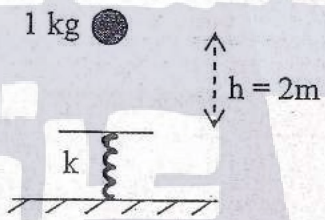
a) 2.3 b) 2.23 c) 3.13
d) 4.43 e) 6.3

17]: The figure shows the relation between the force F_x and the displacement (x) of an object of mass 2.0 kg moving on a smooth surface. The work done on the object from 15 to 35 m (in J) is:



a) 200 b) 162.5 c) 50
d) 87.5 e) 225

18]: If the maximum compression in the spring due to the fall of the object from rest on it is 50 cm, the spring force constant (in N/m) is:



a) 200 b) 100 c) 300
d) 400 e) 150

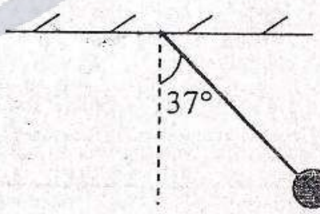
19]: power P is required to lift a body a distance d at a constant speed v. The power required to lift the body a distance 2d at constant speed 3v is:

a) P b) 2P c) 3P d) 6P e) 3P/2

20]: The kinetic energy of a car is 1.0×10^5 J. If the car's speed is increased by 20%, the kinetic energy (in J) of the car becomes:

a) 4.0×10^3 b) 1.2×10^5 c) 1.44×10^5 d) 1.04×10^5 e) unknown

21]: A 30 kg child on a swing 2 m long is released from rest when the swing supports make an angle of 37° with the vertical, as shown in the figure. The energy loss due to friction when reaching the lowest point is 78.4 J. The speed ($m.s^{-1}$) of the child at the lowest point is:



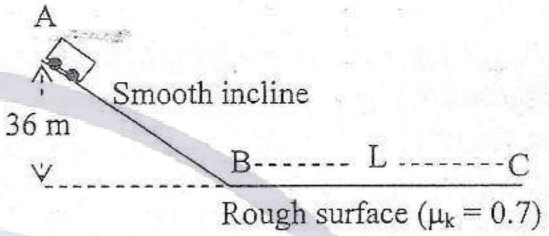
a) 1.6 b) 2.0 c) 2.8
d) 3.0 e) 2.4

22]: A car is initially moving in a horizontal flat road at 18 $m.s^{-1}$. When the driver applies the brakes, the car loses ¾ of its initial kinetic energy after traveling a distance of 30 m. The coefficient of kinetic friction between the car and the road is:

a) 0.17 b) 0.08 c) 0.25 d) 0.41 e) 0.62

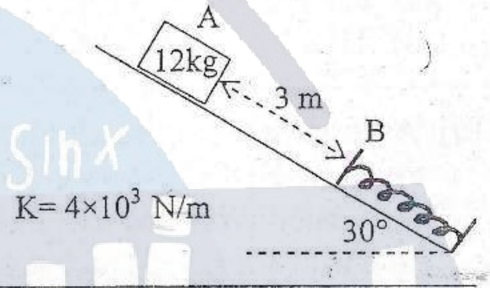
23]: If a car slides from rest from point A and stops completely at point C, then L (in meters) is:

a) 15 b) 30 c) 50
d) 60 e) 75



24]: If the block shown slides from rest from point A and comes to complete stop against the spring at point B after moving 3.0 meters, then the amount the spring has been compressed (in meters) is:

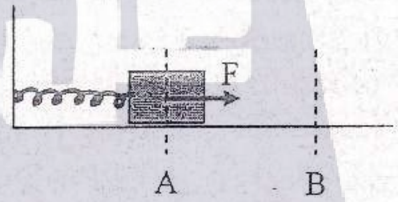
a) 0.50 b) 0.20 c) 0.46
d) 0.30 e) 0.11



25]: A force $F(x) = (2/x^2)$ N is acting on an object. The work done by this force in moving the object from x = 1 to x = 2 (in J) is:

a) -1 b) 1 c) 4/3 d) -4/3 e) -1/2

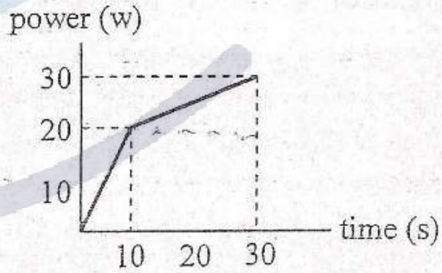
26]: A 0.5 kg block attached to a spring of length 0.6 m and force constant k = 40 N/m is at rest at point A on a horizontal frictionless surface as shown. A constant horizontal force F = 20 N is applied to the block and moves the block to the right. The velocity of the block when is reaches point B, which is 0.25 m to the right of point A (in m/s) is:



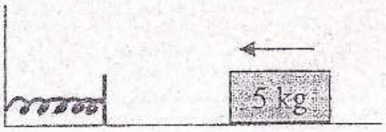
a) 8.82 b) 4.71 c) 3.87 d) 2.5 e) zero

27]: This graph represents the power developed by a motor. The energy (J) expended by the motor in time interval t = 10s to t = 30s is;

a) 200 b) 100
c) 0.5 d) 600
e) 500

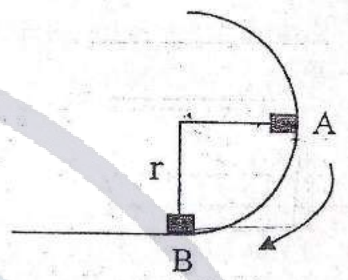


28]: A block of mass 5.0 kg is moving with 3.0 m/s on a rough horizontal surface (coefficient of kinetic friction = 0.40) when it collides with a spring, as shown in the figure, the spring is compressed a maximum distance of 0.20 m. The spring constant (N/m) is:



a) 1020 b) 1804 c) 2196
d) 361 e) 929

29]: A 1.2 kg mass is projected down a rough circular track (radius = 2.0 m) as shown below. The speed of the mass at point A is 3.0 m/s, and at point B, it is 6.0 m/s. How much work is done on the mass between A and B by the force of friction?



a) -9.3 J b) -7.3 J c) -8.1 J
d) -10.8 J e) -24 J

30]: As a particle moves along the x axis it is acted upon by a single conservative force given by $F_x = (20 - 4x)$, where F is in Newton and x in meters. The potential energy associated with this force has the value +96 J at the origin (x = 0). The value of the potential energy (J) at x = 4 m is:

a) -48 b) +78 c) -18 d) +48 e) +80

31]: A 5.0 kg box is lifted by a force equal to the weight of the box. The box moves upward at a constant velocity of 2.0 m/s. The power input of the force (in W) is:

a) 98 b) 48 c) 60 d) 78 e) 24

32]: 1.2 kg object is attached to a horizontal string moves with constant speed in A circle of radius R on a frictionless surface. The kinetic energy of the object is 180 J and the tension in the string is 450 N. The radius of the circle R is:

a) 2.5 b) 1.3 c) 2.1 d) 0.8 e) 0.4

33]: A bullet is fired vertically upward. It loses 2/3 of its kinetic energy when it rises 75 m. The maximum height the bullet can reach is:

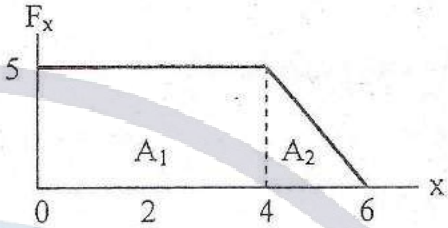
a) 125 m b) 149 m c) 131 m d) 128 m e) 113 m

1] work = area under the curve

$A_1 = (5)(4) = 20$

$A_2 = (\frac{1}{2})(2)(5) = 5$

$w = 20 + 5 = 25 \text{ J}$



c

2] v is constant $\Rightarrow a = 0 \Rightarrow \Sigma f = 0$

$f = weight = mg$

$f = (1.5\times10^4)(9.8) = 1.47\times10^5$

$v = \frac{d}{t} = \frac{25}{6} = 4.17$

$p = f \cdot v = (1.47\times10^5)(4.17) = 6.13\times10^5$ watt

d

3] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$0 - (0.4\times2\times9.8)(0.69) = [(0) - (\frac{1}{2}\times2\times v_i^2)] + [0] + [(\frac{1}{2}\times400\times0.69^2) - (0)]$

$0 - 5.41 = -v_i^2 + 95.22 \Rightarrow v_i^2 = 95.22 + 5.41 = 100.63$

$v_i = \sqrt{100.63} = 10.03$ m/s

c

4] $p = \frac{dw}{dt} \Rightarrow dw = pdt$

$w = \int_{t_1}^{t_2} pdt = \int_0^2 (2 + 2t + 3t^2)dt$

$w = 2t + t^2 + t^3 \Big|_0^2 = [(4 + 4 + 8) - (0)]$

$w = 16$ J

e

5] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$0 - 0 = [(\frac{1}{2}\times6\times v_f^2) - (0)] + [0] + [(0) - (6\times9.8\times1)]$

$0 = 3v_f^2 - 58.8 \Rightarrow v_f^2 = \frac{58.5}{3} = 19.6$

$v_f = \sqrt{19.6} = 4.4$ m/s

e

6] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$0 - \mu_k \times 6 \times 9.8 \times 2.5 = [(0) - (\frac{1}{2} \times 6 \times 4.4^2)] + [0] + [0]$

$-147\mu_k = -58.08$

$\mu_k = \frac{-58.08}{-147} = 0.4$

a

7] $w = \Delta K$

$w = Fd\cos\theta = F \cdot d$

$d = (11i - 5j) - (7i - 8j) = 4i + 3j$

$F \cdot d = (3i + 4j) \cdot (4i + 3j) = 12 + 12 = 24$ J

e

8] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$0 - f_k d = [(0) - (\frac{1}{2} \times 12 \times 20^2)] + [(12 \times 9.8 \times 18) - (0)] + [0]$

$-f_k d = -2400 + 2116.8$

$-f_k d = -283.2$

$f_k d = 283.2 \text{ J} = 0.2832 \text{ kJ}$

The negative sign indicates that this energy is dissipated in air.

c

9] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$0 - 0 = [(\frac{1}{2} \times 2 \times v_f^2) - (0)] + [0] + [(0) - (\frac{1}{2} \times 200 \times 0.5^2)]$

$0 = v_f^2 - 25 \Rightarrow v_f^2 = 25$

$v_f = \sqrt{25} = 5$ m/s

b

10] $F = ma \Rightarrow a = \frac{F}{m}$

$a = \frac{50}{2} = 25 \text{ m/s}^2$

$v_f = v_i + at$

$v_f = 0 + (25)(2) = 50$ m/s

$p = F \cdot v$

$p = (50)(50) = 2500$ watt

a

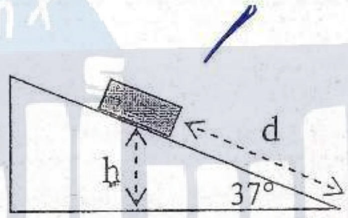
11] The mechanical energy is constant at all positions. **(e)**

12] $K_i = \frac{1}{2}mv_i^2$

$K_f = \frac{1}{2}m(3v_i)^2 = \frac{1}{2}m9v_i^2$

$K_f = 9(\frac{1}{2}mv_i^2) = 9K_i$ **(d)**

13] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$



$0 - \mu_k N d = [(0) - (\frac{1}{2}mv_i^2)] + [(mgh) - (0)] + [0]$

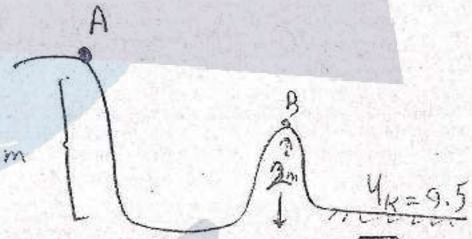
$-\mu_k mg\cos\theta d = -\frac{1}{2}mv_i^2 + mgd\sin\theta$

$-(0.3)(2.4)(9.8)(\cos 37)(d) = -(\frac{1}{2})(2.4)(3.8)^2 + (2.4)(9.8)(d)(\sin 37)$

$-5.635d = -17.328 + 14.155d \Rightarrow 19.79d = 17.328$

$d = \frac{17.328}{19.79} = 0.875$ m **(c)**

14] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$



$0 - 0 = [(\frac{1}{2}mv_f^2) - (0)] + [(m \times 9.8 \times 2) - (m \times 9.8 \times 5)] + [0]$

$0 = \frac{1}{2}v_f^2 + 19.6 - 49 \Rightarrow \frac{1}{2}v_f^2 = 29.4$

$v_f^2 = 58.8 \Rightarrow v_f = \sqrt{58.8} = 7.7$ m/s **(b)**

15] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$0 - \mu_k mgd = [(0) - (\frac{1}{2}mv_i^2)] + [(0) - (mgh_i)] + [0]$

$-(0.5)(9.8)(d) = -(\frac{1}{2})(7.75)^2 - (9.8)(2)$

$-4.9d = -30 - 19.6 \Rightarrow 4.9d = 49.6$

$d = \frac{49.6}{4.9} = 10$ m **(a)**

16] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

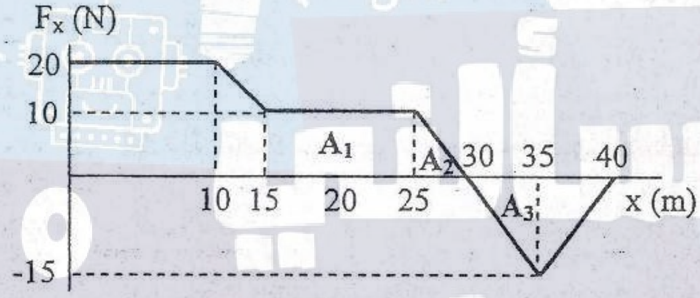
$$0-0=[(\frac{1}{2}\times m\times v_f^2)-(0)]+[(0)-(m\times 9.8\times 0.5)]+[0]$$

$$0=\frac{1}{2}mv_f^2-4.9m \Rightarrow v_f^2=\frac{4.9m}{\frac{1}{2}m}=9.8$$

$$v_f=\sqrt{9.8}=3.13 \text{ m/s}$$

c

17] work = area under the curve



$$A_1=10\times 10=100$$

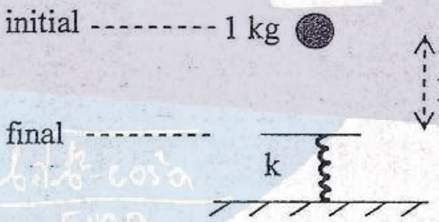
$$A_2=\frac{1}{2}\times 5\times 10=25$$

$$A_3=\frac{1}{2}\times 5\times -15=-37.5$$

$$w=100+25+(-37.5)=87.5 \text{ J}$$

d

18] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$



$$0-0=[0]+[(0)-(mgh_i)]+[(\frac{1}{2}kx_f^2)-(0)]$$

$$0=-(1\times 9.8\times 2.5)+(\frac{1}{2}\times k\times 0.5^2)$$

$$24.5=0.125k \Rightarrow k=\frac{24.5}{0.125}=196 \text{ N/m}$$

a

19] $p=\frac{w}{t}=\frac{Fd\cos\theta}{t}$

$$v=\frac{d}{t} \Rightarrow t=\frac{d}{v}$$

$$\left.\begin{matrix} d\rightarrow 2d \\ v\rightarrow 3v \end{matrix}\right\} t\rightarrow\frac{2d}{3v}=\frac{2}{3}t$$

$$p\rightarrow\frac{F(2d)\cos\theta}{\frac{2}{3}t}=3\frac{Fd\cos\theta}{t}=3p$$

c

20] $K_i = \frac{1}{2}mv_i^2 = 1\times10^5$

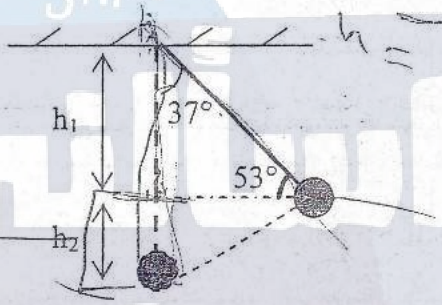
$v_f = \frac{20}{100}v_i + v_i = 1.2v_i$

$K_f = \frac{1}{2}mv_f^2 = \frac{1}{2}m(1.2v_i)^2 = 1.44(\frac{1}{2}mv_i^2)$

$K_f = 1.44K_i = (1.44)(1\times10^5) = 1.44\times10^5$ J

c

21] $h_1 = 2\sin 53 = 1.6$ m $\Rightarrow$ $h_2 = 2 - 1.6 = 0.4$ m



$w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$0 - 78.4 = [(\frac{1}{2}\times30\times v_f^2) - (0)] + [(0) - (30\times9.8\times0.4)] + [0]$

$-78.4 = 15v_f^2 - 117.6$

$15v_f^2 = 117.6 - 78.4 = 39.2$

$v_f^2 = \frac{39.2}{15} = 2.6 \Rightarrow v_f = \sqrt{2.6} = 1.61$ m/s

a

22] $K_i = \frac{1}{2}mv_i^2 = \frac{1}{2}\times m\times18^2 = 162m$

$K_f = K_i - \frac{3}{4}K_i = \frac{1}{4}K_i = (\frac{1}{4})(162m) = 40.5m$

$w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$-\mu_k mgd = [(K_f) - (K_i)] + [0] + [0]$

$-\mu_k\times m\times9.8\times30 = 40.5m - 162m$

$-294\mu_k = -121.5 \Rightarrow \mu_k = \frac{-121.5}{-294} = 0.41$

d

23] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$0 - (0.72\times m\times9.8\times d) = [0] + [(0) - (m\times9.8\times36)] + [0]$

$-7.056d = -352.8$

$d = \frac{-352.8}{-7.056} = 50$ m

c

24] $h_i = 3\sin 30 = 1.5\text{ m}$

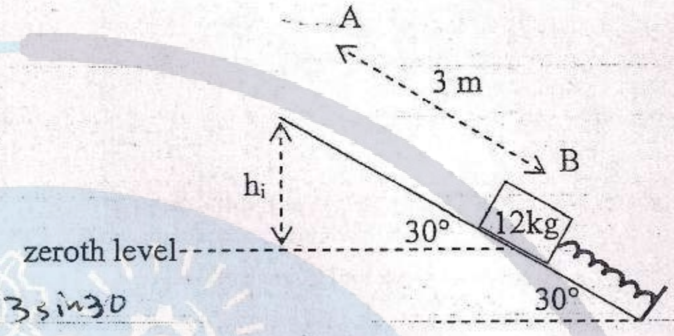
$w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$0 - 0 = [0] + [(0) - (mgh_i)] + [(\frac{1}{2}kx_f^2) - (0)]$

$0 = -(12 \times 9.8 \times 1.5) + (\frac{1}{2} \times 4000 \times x_f^2)$ → 3sin30

$176.4 = 2000x_f^2 \Rightarrow x_f^2 = \frac{176.4}{2000} = 0.0882$

$x = \sqrt{0.0882} = 0.297\text{ m}$



d

25] $w = \int_{x_1}^{x_2} f(x)dx = \int_1^2 \frac{2}{x^2}dx$

$w = \frac{-2}{x}\Big|_1^2 = [\frac{-2}{2} - \frac{-2}{1}] = -1 + 2 = 1\text{ J}$

b

26] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$Fd\cos\theta - 0 = [(\frac{1}{2}mv_f^2) - (0)] + [0] + [(\frac{1}{2}kx_f^2) - (0)]$

$20 \times 0.25 \times 1 = (\frac{1}{2} \times 0.5 \times v_f^2) + (\frac{1}{2} \times 40 \times 0.25^2)$

$5 = 0.25v_f^2 + 1.25 \Rightarrow 0.25v_f^2 = 3.75$

$v_f^2 = \frac{3.75}{0.25} = 15 \Rightarrow v_f = \sqrt{15} = 3.87\text{ m/s}$

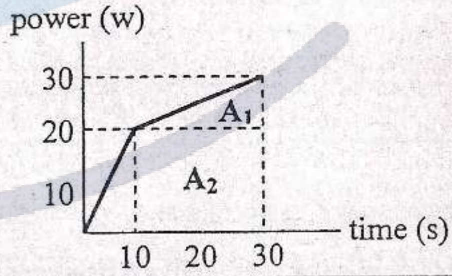
c

27] Energy = area under the curve (from t = 10 to t = 30)

$A_1 = \frac{1}{2} \times 20 \times 10 = 100$

$A_2 = 20 \times 20 = 400$

$E = 100 + 400 = 500\text{ J}$



e

28] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$0 - \mu_k mgd = [(0) - (\frac{1}{2}mv_i^2)] + [0] + [(\frac{1}{2}kx_f^2) - (0)]$

$-0.4 \times 5 \times 9.8 \times 0.2 = -(\frac{1}{2} \times 5 \times 3^2) + (\frac{1}{2} \times k \times 0.2^2)$

$-3.92 = -22.5 + 0.02k \Rightarrow 0.02k = 18.58$

$k = \frac{18.58}{0.02} = 929\text{ N/m}$

e

29] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$0 - f_k d = [(\frac{1}{2}mv_f^2) - (\frac{1}{2}mv_i^2)] + [(0) - (mgh_i)] + [0]$

$-f_k d = [(\frac{1}{2}\times 1.2\times 6^2) - (\frac{1}{2}\times 1.2\times 3.5^2)] - (1.2\times 9.8\times 2)$

$-f_k d = 21.6 - 7.35 - 23.52$

$-f_k d = -9.27 \Rightarrow f_k d = 9.27$ J

The negative sign indicates that this work is done against friction.

a

30] $\Delta U = -\int_{x_i}^{x_f} F_x dx$

$U_f - U_i = -\int_0^4 (20 - 4x)dx$

$U_f - 96 = -(20x - 2x^2|_0^4)$

$U_f - 96 = -[(20\times 4 - 2\times 4^2) - (0 - 0)]$

$U_f - 96 = -48 \Rightarrow U_f = -48 + 96 = 48$ J

d

31] $F = mg = (5)(9.8) = 49$

$p = F\cdot v = Fv\cos\theta$

$p = (49)(2)(\cos 0) = 98$ watt

a

32] $K = \frac{1}{2}mv^2$

$180 = \frac{1}{2}\times 1.2\times v^2 \Rightarrow 180 = 0.6v^2$

$v^2 = \frac{180}{0.6} = 300$

$T = \frac{mv^2}{r} \Rightarrow r = \frac{mv^2}{T}$

$r = \frac{(1.2)(300)}{450} = 0.8$ m

d

33] from point A to point B

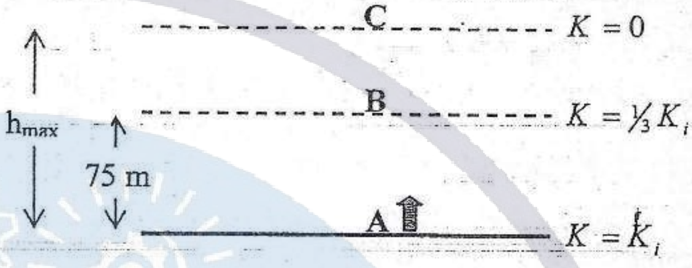
$$K_f = K_i - \tfrac{2}{3}K_i = \tfrac{1}{3}K_i$$

$$w - f_k d = \Delta K + \Delta U_g + \Delta U_s$$

$$0 - 0 = [(K_f - K_i) + (U_f - U_i) + (0)]$$

$$0 = (\tfrac{1}{3}K_i - K_i) + (U_f - 0)$$

$$0 = -\tfrac{2}{3}K_i + U_f \quad \Rightarrow \quad \tfrac{2}{3}K_i = U_f$$



$$\tfrac{2}{3} \times \frac{1}{2} m v_i^2 = m \times 9.8 \times 75$$

$$v_i^2 = \frac{9.8 \times 75}{\tfrac{2}{3} \times \tfrac{1}{2}} = 2205$$

from point A to point C

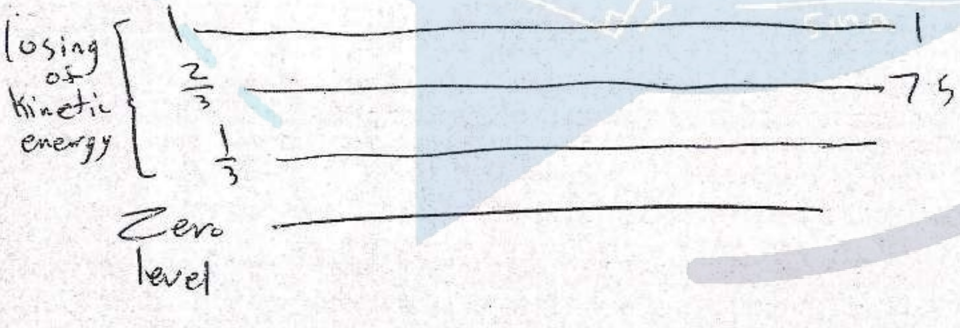
$$w - f_k d = \Delta K + \Delta U_g + \Delta U_s$$

$$0 - 0 = [(0 - K_i) + (U_f - 0) + (0)]$$

$$K_i = U_f \quad \Rightarrow \quad \frac{1}{2} m v_i^2 = m g h_{max}$$

$$h_{max} = \frac{\frac{1}{2} \times v_i^2}{g} = \frac{\frac{1}{2} \times 2205}{9.8} = 112.5 \text{ m}$$

e



so 75 ÷ 2 = 37.5

نضرب 37.5 × 3 لايجاد المسافة الكلية = 112.5

Physics 101
Chapter 9

Linear Momentum and Collisions

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Chapter 9
Linear Momentum and Collisions

1]: When a 0.15 kg baseball is hit, its velocity changes from 20 m/s in the +ve x axis to 20 m/s in the –ve x axis. The baseball is in contact with the bat for 1.3 ms. The average force exerted by the bat on the ball (in kN) is:

a) 2.31 b) 4.62 c) 31.0 d) 216 e) 0.0

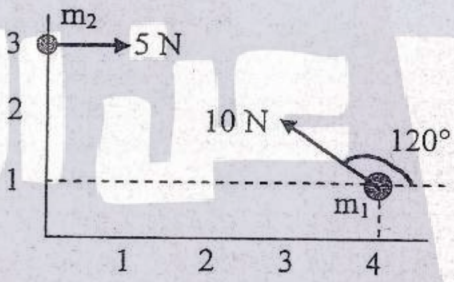
2]: Two masses of 5 kg and 10 kg are connected by a compressed spring and at rest on a frictionless table. After the spring is released, the smaller mass has a velocity of 8 m/s to the left. The velocity of the larger one (in m/s) is:

a) 6 to the right b) 4 to the left c) 8 to the right
d) 4 to the right e) 6 to the left

3]: A constant force of 8 N is exerted for 4 sec on a 16 kg object initially at rest. The change in speed (m/sec) of the object will be:

a) 0.5 b) 2 c) 4 d) 8 e) 32

4]: The figure shows a two particles system m_1 and m_2, both initially at rest. Each particle has been acted upon by an external force shown in this figure. If m_1=1.5 kg and m_2=1.0 kg, the acceleration ($m.s^{-2}$) of the center of mass is:

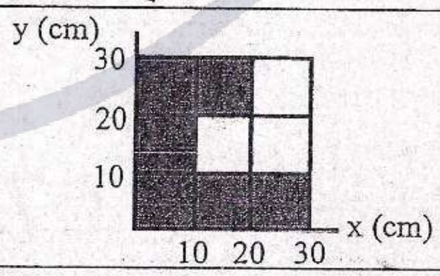


a) 4.3j b) 6.9j c) 3.5j
d) 2.2j e) 8.1j

5]: Three particles are placed in the x-y plane. A 40 g particle is located at (3,4), and a 50 g particle is positioned at (-2,-6). Where must a 20 g particle be placed so that the center of mass of this three-particle system is located at the origin?

a) (-1,-3) b) (-1,2) c) (-1,12) d) (-1,7) e) (-1,3)

6]: A uniform piece of sheet steel is shaped as shown (dark parts). The x and y component of the center of mass of the piece (in cm) is:



a) (13.3 , 11.7) b) (13.6 , 15) c) (15 , 15)
d) (11.7 , 13.3) e) (15 , 13.6)

7]: A 6.0 kg object moving 2.0 m/s in the positive x direction has one-dimensional elastic collision with a 4.0 kg object moving 3.0 m/s in the opposite direction. What is the total kinetic energy of the two mass system after the collision?

a) 30 J b) 62 J c) 20 J d) 44 J e) 24 J

8]: The physical quantity (impulse) has the same dimensions as that of:

a) force b) power c) energy d) momentum e) work

I=ΔP

9]: At the instant a 2.0 kg particle has a velocity of 4.0 m/s in the positive x direction, a 3.0 kg particle has a velocity of 5.0 m/s in the positive y direction. What is the speed (in m/s) of the center of mass of the two-particle system?

a) 3.8 b) 3.4 c) 5.0 d) 4.4 e) 4.6

10]: A proton of mass m and velocity of 300 m/s collides elastically in one dimension with a stationary carbon nucleus of mass 12m. The velocity of center of mass of the system in m/s is:

a) 23.1 b) 25 c) 277 d) cannot be determined

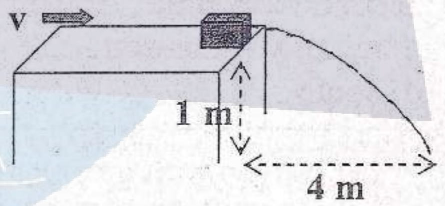
11]: A 0.3 kg object is dropped from a height of 5 m. It hits the ground and stops. The magnitude of the impulse (in N.s) exerted by the ground on the brick is:

a) 47 b) 3.0 c) zero d) 15

12]: A 3 kg bomb slides along a frictionless horizontal plane in the x direction with velocity of 6 m/s. It explodes into two pieces with masses of 1 kg and 2 kg. The 1 kg mass moves in the y direction with a speed of 4 m/s. The velocity of the 2 kg mass in m/s is :

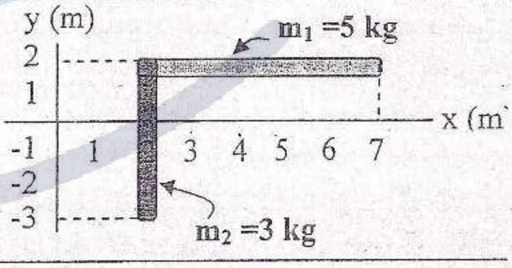
a) 6i b) 18i – 4j c) 9i – 2j d) -9i + 2j

13]: A bullet of mass m=10 grams traveling horizontally strikes a box (mass = 3 kg) sitting on a frictionless table at a height h = 1 m, and is embedded in the box. The box-bullet system flies off the table and lands 4 m away. What is the initial bullet velocity in m/s?



a) 538 b) 8.94 c) 26.82 d) 2680

14]: Calculate the center of mass x and y coordinates (in m) for the system in figure.



a) (2.0 , 2.5) b) (28.5 , 8.5)
c) (-0.5 , 4.5) d) (3.56 , 1.06)

15]: Two bodies A and B moves toward each other with speeds of 80 cm/s and 20 cm/s respectively. The mass of A is 140 g and that of B is 60 g. After a head-on perfectly elastic collision, the speed (in cm/s) of B is:

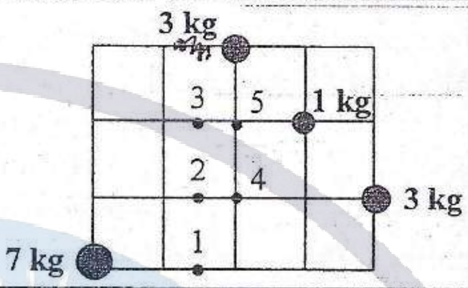
a) 8.0 b) 20 c) 92 d) 120 e) 130

16]: A 0.3 kg ball moving along a straight line has a velocity of 5i m/s. It collides with a wall and rebound with a velocity of -4i m/s. If the ball is in contact with the wall for 5×10^{-3} s. The average force (in N) exerted on the wall is:

a) -540i b) 540i c) -60i d) 60i e) 2.7i

17]: The center of mass of the system of particles shown in the diagram is at point:

a) 1
b) 2
c) 3
d) 4
e) 5



18]: A block of wood with a mass M = 4.65 kg is resting on horizontal surface, when a bullet with a mass m = 18 g and moving with speed v = 725 m/s strikes it. The coefficient of friction between the block and the surface is $\mu = 0.35$. The distance the block moves across the surface is:

a) 1.1 m   b) 3.3 m   c) 0.41 m   d) 11 m   e) 15.1 m

19]: Two moving objects collide with each other in the absence of external forces. Which of the following statements is almost true for the two-object system?

a) The linear momentum of each object remains constant.
b) Kinetic energies of the system is constant whether the collision is elastic or inelastic
c) Both objects will always move in different directions after collision.
d) None of the above.

20]: A bomb at rest explodes into three unequal fragments. The first went north and the second went south. The third fragment went:

a) either west or east   b) either north or south   c) north
d) south   e) none of the above

21]: A car moves with a velocity of 18 m/s due to west collides with a massive wall and rebounds after losing 0.75 of its kinetic energy as a result of the collision. The magnitude of the impulse force (N.s) an 80 kg rider will experience during the collision is:

a) 540   b) 1620   c) 720   d) 2160   e) 2430

22]: A 10 g bullet is fired into 2.5 kg ballistic pendulum and becomes embedded in it. If the pendulum rises a vertical distance of 8.0 cm, the initial speed of the bullet (m/s) is:

a) 313.8   b) 308.4   c) 268.7   d) 19.8   e) 2.6

23]: Car (A) of 1000 kg mass of 20 m/s speed collides head-on with car (B) of 2500 kg mass. They stop exactly after collision. The speed (in m/s) of car (B) before collision was:

a) 5.7   b) 8   c) 20   d) 60   e) 4

1] $\bar{F}\Delta t = mv_f - mv_i$

$(\bar{F})(1.3\times10^{-3}) = (0.15)(-20) - (0.15)(20)$

$\bar{F} = \dfrac{-3-3}{1.3\times10^{-3}} = \dfrac{-6}{1.3\times10^{-3}} = -4.62\times10^{3}$

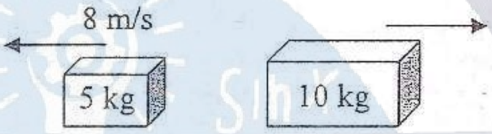
$\left|\bar{F}\right| = \left|-4.62\times10^{3}\right| = 4.62\times10^{3} = 4.62\ kN$

b

2] $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$

$0 + 0 = (5)(-8i) + (10)(v_{2f})$

$40i = 10v_{2f} \Rightarrow v_{2f} = \dfrac{40i}{10} = 4i$ (to the right)



d

3] $\bar{F}\Delta t = mv_f - mv_i \Rightarrow \bar{F}\Delta t = m\Delta v$

$(8)(4) = (16)(\Delta v) \Rightarrow \Delta v = \dfrac{32}{16} = 2$ m/s

b

4] $a_{CM} = \dfrac{\sum_i m_i a_i}{\sum_i m_i} = \dfrac{\sum_i F_i}{\sum_i m_i}$

$F_{1x} = F_1\cos120 = (10)(\cos120) = -5i$

$F_{1y} = F_1\sin120 = (10)(\sin120) = 8.66j$

$F_{2x} = F_2\cos0 = (5)(\cos0) = 5i$

$F_{2y} = F_2\sin0 = (5)(\sin0) = 0$

$a_{CM} = \dfrac{(-5i+5i)+(8.66j+0)}{1.5+1} = 0i + 3.46j$

$a_{CM} = 3.46$ m/s^2

c

5] $X_{CM} = \dfrac{\sum_i m_i x_i}{\sum_i m_i} = 0 = \dfrac{(40)(3)+(50)(-2)+20)(x)}{40+50+20}$

$0 = 120 - 100 + 20x \Rightarrow x = -1$

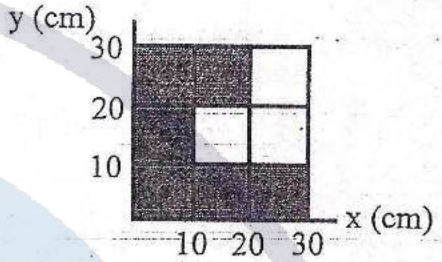
$Y_{CM} = \dfrac{\sum_i m_i y_i}{\sum_i m_i} = 0 = \dfrac{(40)(4)+(50)(-6)+(20)(y)}{40+50+20}$

$0 = 160 - 300 + 20y \Rightarrow y = 7$

d

The particle must placed at (-1,7)

6] We will take the center of each square as the center of mass of the square.



$$X_{CM} = \frac{\sum_i m_i x_i}{\sum_i m_i}$$

$$X_{CM} = \frac{(m)(5)+(m)(5)+(m)(5)+(m)(15)+(m)(15)+(m)(25)}{6m}$$

$$X_{CM} = \frac{70m}{6m} = 11.7$$

$$Y_{CM} = \frac{\sum_i m_i y_i}{\sum_i m_i}$$

$$Y_{CM} = \frac{(m)(5)+(m)(5)+(m)(5)+(m)(15)+(m)(25)+(m)(25)}{6m}$$

$$Y_{CM} = \frac{80m}{6m} = 13.3$$

The center of mass at (11.7 , 13.3)

d

7] The collision is elastic

$\therefore\ \Sigma K_i = \Sigma K_f$

$$\left.\begin{aligned} K_{1i} &= \frac{1}{2} m_1 v_{1i}^2 = (\frac{1}{2})(6)(2)^2 = 12\ \text{J} \\ K_{2i} &= \frac{1}{2} m_2 v_{2i}^2 = (\frac{1}{2})(4)(3)^2 = 18\ \text{J} \end{aligned}\right\} \Sigma K_i = 12 + 18 = 30\ \text{J}$$

a

8] Momentum.

d

9] $v_{CM} = \frac{\sum_i m_i v_i}{\sum_i m_i} = \frac{(2)(4i)+(3)(5j)}{2+3}$

$$v_{CM} = \frac{8}{5} i + \frac{15}{5} j = 1.6i + 3j$$

$$|v_{Cm}| = \sqrt{(1.6)^2 + (3)^3} = 3.4\ \text{m/s}$$

b

10] $v_{CM} = \frac{\sum_i m_i v_i}{\sum_i m_i} = \frac{(m)(300)+(12m)(0)}{m+12m}$

$$v_{CM} = \frac{300m}{13m} = 23.1\ \text{m/s}$$

a

11] We must find the speed of the object when it hits the ground.

$v_2^2 = v_1^2 + 2a\Delta y$

~~$v_2^2 = 0 + (2)(9.8)(5) = 98$~~ $\Rightarrow v_2 = \sqrt{98} = 9.9$ m/s $\Rightarrow 0 = V_i^2 + (2)(-9.8)(5)$

$I = mv_f - mv_i = (0.3)(0) - (0.3)(9.9)$

$I = -3 \Rightarrow |I| = 3$ N.s

b

12] $(v_{CM})_{\text{before}} = (v_{CM})_{\text{after}}$

$\frac{(3)(6i)}{3} = \frac{(1)(4j) + (2)(v)}{3} \Rightarrow 18i = 4j + 2v$

$2v = 18i - 4j \Rightarrow v = 9i - 2j$

c

13] y-direction

$\Delta y = v_i t + \frac{1}{2}at^2 \Rightarrow 1 = 0 + (\frac{1}{2})(9.8)(t^2)$

$1 = 4.9t^2 \Rightarrow t^2 = \frac{1}{4.9} = 0.2 \Rightarrow t = 0.45$ s

x-direction

$\Delta x = v_i t \Rightarrow 4 = (v_i)(0.45)$

$v_i = \frac{4}{0.45} = 8.9$ m/s

$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2)v_f$

$(10\times10^{-3})(v_{1i}) + 0 = (10\times10^{-3} + 3)(8.9)$

$0.01\, v_{1i} = 26.8 \Rightarrow v_{1i} = \frac{26.8}{0.01} = 2680$ m/s

d

14] We will take the center of each bar as the center of mass of the bar.

$CM_1 = (4.5\ ,\ 2) \Rightarrow CM_2 = (2\ ,\ -0.5)$

$$X_{CM} = \frac{\sum_i m_i x_i}{\sum_i m_i} = \frac{(5)(4.5) + (3)(2)}{5+3} = \frac{28.5}{8} = 3.56$$

$$Y_{CM} = \frac{\sum_i m_i y_i}{\sum_i m_i} = \frac{(5)(2) + 3)(-0.5)}{5+3} = \frac{8.5}{8} = 1.06$$

The center of mass at (3.56 , 1.06)

d

15] body A: $m_1 = 140$ g , $v_{1i} = 80$ cm/s

body B: $m_2 = 60$ g , $v_{2i} = -20$ cm/s

$$v_{2f} = (\frac{2m_1}{m_1+m_2})v_{1i} + (\frac{m_2-m_1}{m_1+m_2})v_{2i}$$

$$v_{2f} = (\frac{2\times140}{140+60})\times80 + (\frac{60-140}{140+60})\times-20$$

$$v_{2f} = (1.4)(80) + (-0.4)(-20)$$

$$v_{2f} = 112 + 8 = 120 \text{ cm/s}$$

d

16] $\bar{F}\Delta t = mv_f - m_i$

$$(\bar{F})(5\times10^{-3}) = (0.3)(-4i) - (0.3)(5i)$$

$$\bar{F} = \frac{-1.2i - 1.5i}{5\times10^{-3}} = \frac{-2.7}{5\times10^{-3}} = -540i \text{ N}$$

a

17] $$X_{CM} = \frac{\sum_i m_i x_i}{\sum_i m_i} = \frac{(7)(0)+(3)(2)+(1)(3)+(3)(4)}{7+3+1+3} = \frac{21}{14} = 1.5$$

$$Y_{CM} = \frac{\sum_i m_i y_i}{\sum_i m_i} = \frac{(7)(0)+(3)(1)+(1)(2)+(3)(3)}{7+3+1+3} = \frac{14}{14} = 1$$

The center of mass at (1.5 , 1) which is indicated by point 2

b

18] $m_1v_{1i} + m_2v_{2i} = (m_1+m_2)v_f$

$$0 + (18\times10^{-3})(725) = (4.65 + 18\times10^{-3})v_f$$

$$13.05 = 4.668v_f \Rightarrow v_f = \frac{13.05}{4.668} = 2.8 \text{ m/s}$$

$$w - f_k d = \Delta K + \Delta U_g + \Delta U_s$$

$$0 - (4.668)(9.8)(0.35)(d) = [(0) - (\frac{1}{2}\times4.668\times2.8^2)] + [0] + [0]$$

$$16.01\,d = 18.3 \Rightarrow d = \frac{18.3}{16.01} = 1.1 \text{ m}$$

a

19] None of the above.

d

20] Either north or south.

b

11] We must find the speed of the object when it hits the ground.

$v_2^2 = v_1^2 + 2a\Delta y$

~~$v_2^2 = 0 + (2)(9.8)(5) = 98$~~ $\Rightarrow v_2 = \sqrt{98} = 9.9$ m/s $\Rightarrow 0 = V_i^2 + (2)(-9.8)(5)$

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c

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x-direction

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$v_i = \frac{4}{0.45} = 8.9$ m/s

$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2)v_f$

$(10\times10^{-3})(v_{1i}) + 0 = (10\times10^{-3} + 3)(8.9)$

$0.01\, v_{1i} = 26.8 \Rightarrow v_{1i} = \frac{26.8}{0.01} = 2680$ m/s

d

14] We will take the center of each bar as the center of mass of the bar.

$CM_1 = (4.5\ ,\ 2) \Rightarrow CM_2 = (2\ ,\ -0.5)$

$$X_{CM} = \frac{\sum_i m_i x_i}{\sum_i m_i} = \frac{(5)(4.5) + (3)(2)}{5+3} = \frac{28.5}{8} = 3.56$$

$$Y_{CM} = \frac{\sum_i m_i y_i}{\sum_i m_i} = \frac{(5)(2) + 3)(-0.5)}{5+3} = \frac{8.5}{8} = 1.06$$

The center of mass at (3.56 , 1.06)

d

21] $K_i = \frac{1}{2}mv_i^2 = (\frac{1}{2})(m)(18)^2 = 162m$

$K_f = \frac{1}{2}mv_f^2 \quad ..... \{1\}$

$K_f = 0.25K_i = (0.25)(162m) = 40.5m \quad ..... \{2\}$

$\{1\} = \{2\} \Rightarrow \frac{1}{2}mv_f^2 = 40.5m \Rightarrow v_f^2 = \frac{40.5}{\frac{1}{2}}$

$v_f^2 = 81 \Rightarrow v_f = \sqrt{81} = 9$ m/s

$I = mv_f - mv_i = (80)(9) - (80)(-18)$

$I = 720 + 1440 = 2160$ N.s

d

22] $w - f_k d = \Delta K + \Delta U_g + \Delta U_s$

$0 - 0 = [(\frac{1}{2}mv_f^2) - (\frac{1}{2}mv_i^2)] + [(mgh_f) - (mgh_i)] + [0]$

$0 = [(0) - (\frac{1}{2} \times 2.51 \times v_i^2)] + [(2.51 \times 9.8 \times 0.08) - (0)]$

$0 = -1.255v_i^2 + 1.97 \Rightarrow v_i^2 = \frac{1.97}{1.255} = 1.57$

$v_i = \sqrt{1.57} = 1.25$ m/s ⟸ الجسم كامل

$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2)v_f$

$(10 \times 10^{-3})(v_{1i}) + 0 = (10 \times 10^{-3} + 2.5)(1.25)$

$10 \times 10^{-3} \; v_{1i} = 3.138 \Rightarrow v_{1i} = \frac{3.138}{10 \times 10^{-3}} = 313.8$ m/s

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23] $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$

$(1000)(20) + (2500)(v_{2i}) = 0 + 0$

$20000 = -2500 \; v_{2i} \Rightarrow v_{2i} = \frac{20000}{-2500} = -8$

speed $= |-8| = 8$ m/s

b

Chapter 10

Rotation of a Rigid Object About Fixed Axis

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Chapter 11

Rolling Motion and Angular Momentum

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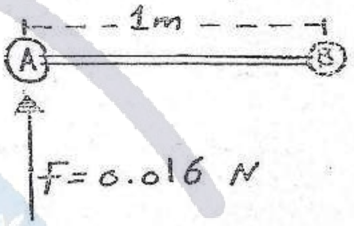
CH 10: Rotation of a Rigid Object About a Fixed Axis
CH 11: Rolling Motion and Angular Momentum

[1]: A wheel rotates through 6.0 rad in 2.0 s as it is uniformly brought to rest. The initial angular velocity (in rad/s) of the wheel before braking began was:
a) 0.6 b) 0.9 c) 1.8 d) 6.0 e) 7.2

[2]: Two small masses, $m_A = 4.0\times10^{-3}$ kg and $m_b = 2.0\times10^{-3}$ kg, are connected by 1.0 m rod of negligible mass. The angular acceleration (in rad/s^2)about B produced by a force of 0.016 N applied at A is:



a) 4.0 b) 2.7 c) 11
d) 12 e) 400

[3]: A solid cylinder has a moment of inertia of 2 kg.m^2. It is at rest at time zero when a net torque given by: [$\tau = 6t^2 + 6$ (SI units)] is applied. After 2 s, the angular velocity (rad/s) of the cylinder will be:
a) 3.0 b) 12 c) 14 d) 24 e) 28

[4]: Four 50-g point masses are at the corners of a square with 20-cm sides. What is the moment of inertia (kg.m^2) of this system about an axis perpendicular to the plane of the square and passing through its center?
a) 1.0×10^{-3} b) 8.0×10^{-3} c) 4.0×10^{-3} d) 2.8×10^{-3} e) 2.0×10^{-3}

[5]: The angular position of a point on a wheel can be described by $\theta = 5 + 10t + 2t^2$ rad. The angular acceleration of the point (in rad/s^2) at t = 3s is:
a) 43 b) 22 c) 4.0 d) zero e) 14

[6]: A wheel starts from rest and rotates about a fixed axis with constant angular acceleration of 4 rad/s^2. What time it take to complete 20 revolutions?
a) 5.6 sec b) 3.2 sec c) 4.0 sec d) 7.9 sec e) 11.4 sec

[7]: A 2.5 kg cylinder of radius 11 cm is initially at rest. A rope of negligible mass is wrapped around it and pulled with a force of 17 N. The torque (in N.m) on the cylinder is:
a) 154.5 b) 187 c) 1.87 d) cannot be determined

[8]: A car accelerates uniformly from rest to speed of 22 m/s in 9 sec. If the diameter of the tire is 58 cm, the final rotational speed of the tire in rev/sec is:
a) 4.21 b) 37.9 c) 6.03 d) 12.08

[9]: An object of mass M is rotating about a fixed axis with angular momentum L. If its moment of inertia about the axis is I then its kinetic energy is:
a) $I L^2/2$ b) $L^2/(2 I)$ c) $M L^2/2$ d) $I L^2/(2 M)$

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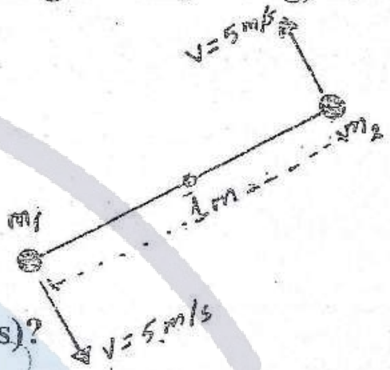
CH 10: Rotation of a Rigid Object About a Fixed Axis
CH 11: Rolling Motion and Angular Momentum

A massless rod 1.0 m in length joins two particles ($m_1 = 4$ kg and $m_2 = 6$ kg) as shown. The system rotates around an axis through the middle perpendicular to line joining the two particles. The linear speed of each particle is 5 m/s.



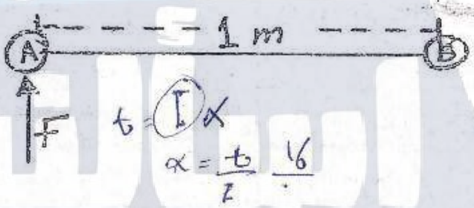
[10]: What is the moment of inertia (in kg.m^2) of the system about the axis of rotation?

a) 10 b) 5 c) 2.5 d) 6

[11]: What is the angular momentum of the system (in kg.m^2/s)?

a) 100 b) 250 c) 125 d) 25

[12]: Two small masses m_A= 4 kg and m_B= 2 kg are connected by 1.0 m rod of negligible mass, as shown. The angular acceleration (in rad/s^2) about B produced by a force of 16 N applied at A is:

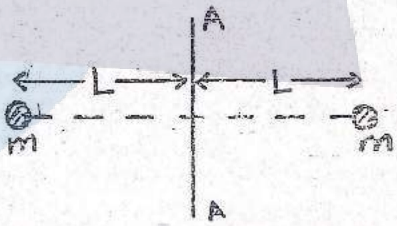


a) 4.0 b) 2.7 c) 11 d) 12 e) 400

[13]: A disk rotates about an axis through its center with an angular velocity of 40 rad/s. If the rotational kinetic energy of the disk is 400 j, its angular momentum (in kg.m^2/s) is

a) 800 b) 400 c) 200 d) 20 e) 5

[14]: The moment of inertia of a set of dumbbells considered as two mass point m`separated by a distance 2L about the axis AA is:

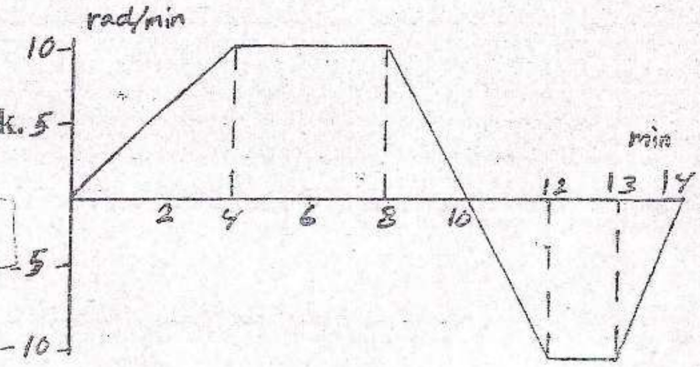


a) mL^2 b) ½ mL^2 c) $2mL^2$
d) ¼ mL^2 e) $4mL^2$

[15]: At t = 0, a wheel rotating about a fixed axis at a constant angular acceleration has an angular velocity of2.0 rad/s. Two seconds later it has turned through 5.0 complete revolutions. What is the angular acceleration (in rad/s^2) of this wheel?

a) 17 b) 14 c) 20 d) 23 e) 13

[16]: The figure below shows a graph of angular velocity as a function of time for a car driving around circular track. Through how many radians dose the car travel in the first 10 minutes?



a) 30 b) 50 c) 70
d) 90 e) 100

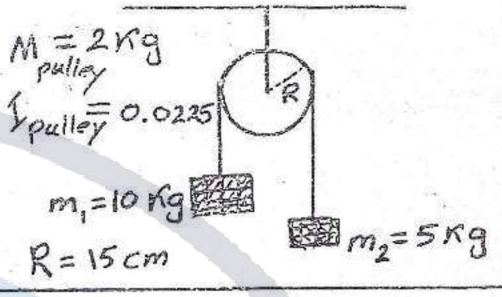
General Physics 101

Khalil Bazz 079 5811944

CH 10: Rotation of a Rigid Object About a Fixed Axis

CH 11: Rolling Motion and Angular Momentum

[17]: The string connecting m_1 and m_2 is massless and the pulley rotates without friction. The system starts moving from rest as shown. What is the acceleration (in m/s^2) of the masses?



a) 10 b) 9.38

c) 3.13 d) 5

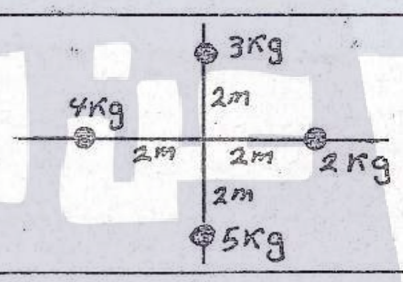
[18]: A cord attached to a 3.63 kg mass is wrapped around a wheel of radius 0.61 m and released. The moment of inertia of the wheel is 2.7 kg.m^2. If the wheel rotates on frictionless bearings, the acceleration (m/s^2) of the falling weight is:

a) 3.26 b) 1.04 c) 2.44 d) 1.95 e) 4.27

[19]: A solid sphere ($I = 0.4MR^2$) of radius 0.06 m and mass 0.50 kg rolls without slipping 14 m down a 30° inclined plane. At the bottom of the plane, the linear velocity of the center of mass of the sphere is approximately:

a) 3.5 m/s b) 3.9 m/s c) 8.7 m/s d) 18 m/s e) 9.9 m/s

[20]: A system of four particles as shown, is rotating about the z-axis with an angular speed of 2.83 rad/s. Find the kinetic energy of the system.



a) 112 J b) 56 J c) 64 J

d) 224 J e) 424 J

[21]: A 20 kg child stands at the center of a disk which has a 3 m radius and a 600 kg.m^2 moment of inertia, and rotates with an angular speed of 2.1 rad/s. Find the angular speed of the disk as the child walks from the center of the rim of the disk.

a) 1.6 rad/s b) 2.7 rad/s c) 0.8 rad/s d) 0.61 rad/s e) 0.3 rad/s

[22]: A rope is wrapped around a cylinder of radius 0.1 m and a moment of inertia $I = 0.02$ kg.m^2. If the free end of the rope is pulled by a force $F = 2$ N, what is the angular acceleration (in rad/s^2) of the cylinder?

a) 5 b) 0.5 c) 10 d) 2 e) 7.5

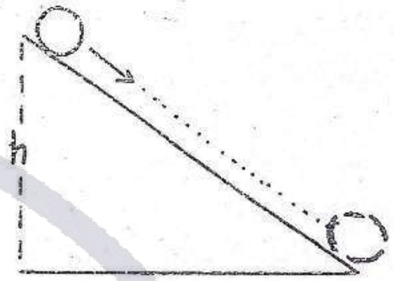
[23]: A 3 kg object has a velocity ($v = 5i + 3j$) m/s at the position ($r = -3i + 2j$). What is its angular momentum about the origin?

a) -57 k b) 24 k c) 24 (i + j) d) 57 k e) -24 k

[24]: A 2 kg disk of radius 20 cm rotates with angular speed of 10 rev/sec. A point mass is attached to the rim of the disk. What is the linear speed of the mass?

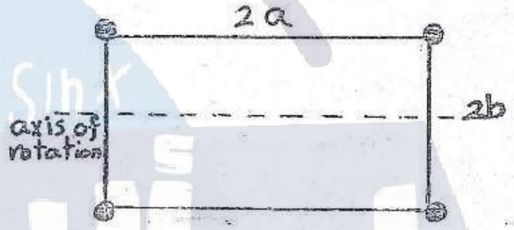
a) 4 m/s b) 12.6 m/s c) 0.64 m/s d) 6 e) 5.2 m/s

[25]: A solid sphere of ($M = 2$ kg, $R = 10$ cm, $I = 2MR^2/5$) rolls without slipping down an incline starting from rest and from a height ($h = 130$ cm). Find the velocity of the center of mass of the sphere at the lowest point on the incline, in units of m/s.



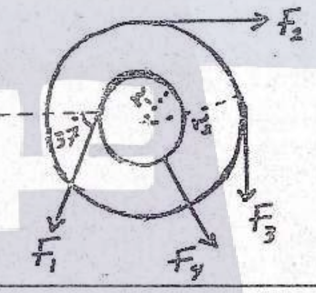
a) 3.6 b) 4.3 c) 3.4
d) 6.7 e) 8.2

[26]: Four identical particles each of mass m are connected by a massles rods to form a rectangle of side 2a and 2b as shown in the figure. What is the moment of inertia of the system about the shown axis of rotation?



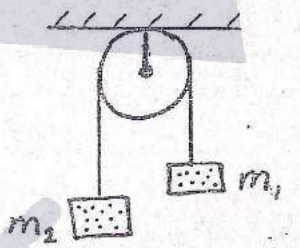
a) $4mb^2$ b) $4ma^2$ c) zero
d) $4m(a^2 + b^2)$ e) $4m(a^2 - b^2)$

[27]: In the figure shown, F_1=10 N, F_2=4 N, F_3=2N, F_4=4 N. If r_1=0.1 m, r_2=0.2 m, what is the net torque (in N.m) acting on the wheel about the axle passing through its center?



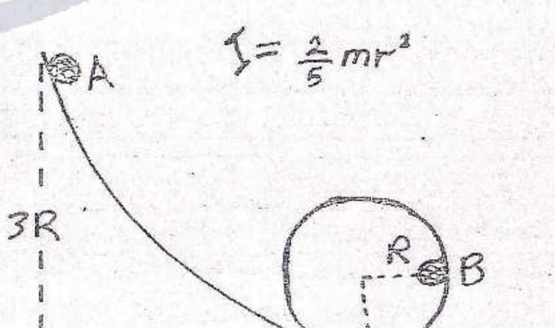
a) -0.2 b) 0.2 c) 1.4
d) -0.6 e) 0.6

[28]: Two blocks m_1=1 kg and m_2=2 kg are connected by a light string as shown in the figure below. If the radius of the pulley (1 m) and its moment of inertia is (5 kg.m^2). What is the acceleration of the system ?



a) (1/8)g b) (3/8)g c) (1/6)g
d) (3/6)g e) (5/8)g

[29]: A ball of radius r and mass m rolls without slipping along the shown track in the figure. If the ball start from rest at point A at height of 3R above the bottom of the track. What is the speed of its center of mass at point B?



a) $\sqrt{10\ gR/7}$ b) $\sqrt{20\ gR/7}$ c) $\sqrt{10\ gR}$
d) $\sqrt{20\ gR}$ e) $\sqrt{g}$

[1]:

$\omega_f = \omega_i + \alpha t \Rightarrow 0 = \omega_i + 2\alpha$

$\omega_i = -2\alpha \Rightarrow \alpha = -\frac{\omega_i}{2}$

$\Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2$

$6 = (\omega_i)(2) + \frac{1}{2}\left(-\frac{\omega_i}{2}\right) 4$

$6 = 2\omega_i - \omega_i \Rightarrow \omega_i = 6 \text{ rad/s}$

d

[2]:

$\tau = I\alpha \Rightarrow \alpha = \frac{\tau}{I}$

$\tau = Fr = (0.016)(1) = 16\times10^{-3}$

$I = \sum m_i r_i^2 = (4\times10^{-3})(1)^2 = 4\times10^{-3}$

$\therefore \alpha = \frac{16\times10^{-3}}{4\times10^{-3}} = 4 \text{ rad/s}^2$

a

[3]:

$\tau = I\alpha \Rightarrow \alpha = \frac{\tau}{I}$

$\alpha = \frac{6t^2+6}{2} = 3t^2+3$

$\omega = \int_0^2 \alpha\, dt = \int_0^2 (3t^2+3)\,dt = t^3+3t \Big|_0^2$

$\omega = (8+6)-(0) = 14 \text{ rad/s}$

c

[4]:

$r^2 = (10\times10^{-2})^2 + (10\times10^{-2})^2$ باستخدام نظرية فيثاغورس

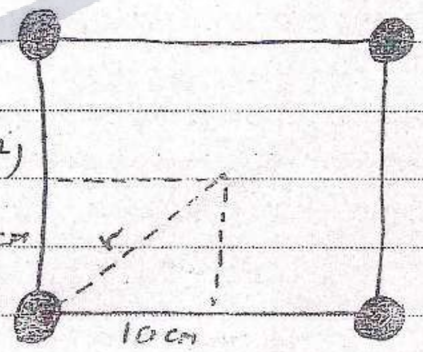
$r^2 = 2\times10^{-2}$

$I = \sum m_i r_i^2$

$I = (50\times10^{-3})(2\times10^{-2}) + (50\times10^{-3})(2\times10^{-2})$

$+ (50\times10^{-3})(2\times10^{-2}) + (50\times10^{-3})(2\times10^{-2})$

$I = (4)(50\times10^{-3})(2\times10^{-2}) = 4\times10^{-3}$



c

[5]: $\omega = \frac{d\theta}{dt} = 10 + 4t$

$\alpha = \frac{d\omega}{dt} = 4 \Rightarrow \alpha = 4\ rad/s^2$

c

[6]: 20 revolutions $\Rightarrow 20 \times 2\pi = 125.7\ rad$

$\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$

$\omega_f^2 = 0 + (2)(4)(125.7) = 1005.6$

$\omega_f = 31.7$

$\omega_f = \omega_i + \alpha t$

$31.7 = 0 + (4)t \Rightarrow t = \frac{31.7}{4} = 7.9\ sec$

d

[7]: $\tau = Fr = (17)(0.11) = 1.87\ N.m$

c

[8]: $\omega_f = \frac{V_f}{r} \Rightarrow$ نجد أولاً نصف قطر العجل

diameter = 2r $\Rightarrow$ 0.58 = 2r $\Rightarrow$ r = 0.29

$\omega_f = \frac{22}{0.29} = 75.86\ rad/s$

للتحويل إلى (rev/s) نقسم على (2π)

$\omega_f = \frac{75.86}{2\pi} = 12.08\ rev/s$

d

[9]:

$K = \frac{1}{2} I \omega^2$, where $L = I\omega$

$K = \frac{1}{2} I \omega^2 \times \left(\frac{I}{I}\right)$ نضرب ونقسم على I

$K = \frac{1}{2} I^2 \omega^2 \left(\frac{1}{I}\right) = \frac{1}{2} L^2 \left(\frac{1}{I}\right)$

$K = L^2/2I$

b

[10]: $I = \sum_i m_i r_i^2 = (4)(0.5)^2 + (6)(0.5)^2 = 2.5\ Kg.m^2$

c

[11]: $L = I\omega = I\frac{v}{r} = \frac{(2.5)(5)}{0.5} = 25\ Kg.m^2/s$

d

[12]: $\tau = I\alpha \Rightarrow \alpha = \frac{\tau}{I}$

$\tau = Fr = (16)(1) = 16$

$I = \sum_i m_i r^2 = (4)(1)^2 + 0 = 4$

$\alpha = \frac{16}{4} = 4\ rad/s^2$

a

[13]: $K = \frac{1}{2}I\omega^2 \Rightarrow I = \frac{2K}{\omega^2} = \frac{(2)(400)}{(1600)} = 0.5$

$L = I\omega = (0.5)(40) = 20\ Kg.m^2/s$

d

[14]: $I = \sum_i m_i r_i^2 = (m)(L)^2 + (m)(L)^2 = 2mL^2$

c

[15]: $\Delta\theta = 5\ revolutions = (5)(2\pi) = 10\pi = 31.4$

$\Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2$

$31.4 = (2)(2) + \frac{1}{2}\alpha(2)^2$

$27.4 = 2\alpha \Rightarrow \alpha = 13.7\ rad/s^2$

b

[16]: $\Delta\theta$ = Area under curve نجد المساحة تحت المنحنى

$I = \frac{1}{2} * 4 * 10 = 20\ rad$

$II = 4 * 10 = 40\ rad$

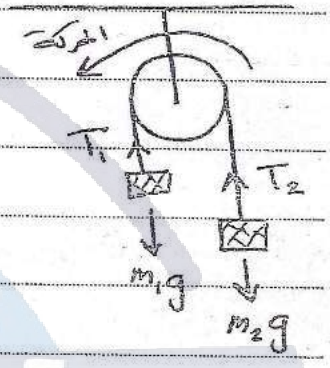
$III = \frac{1}{2} * 2 * 10 = 10\ rad$

$\Delta\theta = 20 + 40 + 10 = 70\ rad$

c

[17]: تتعرض البكرة لقوة محصلة مقدارها $T_1 - T_2$ اعتبر $(g = 10)$

أي انها تتعرض لعزم مقداره $(T_1 - T_2)r$



$m_1g - T_1 = m_1a \Rightarrow 100 - T_1 = 10a$

$\therefore T_1 = 100 - 10a \quad \ldots (1)$

$T_2 - m_2g = m_2a \Rightarrow T_2 - 50 = 5a$

$\therefore T_2 = 50 + 5a \quad \ldots (2)$

$T_1 - T_2 = 50 - 15a$

$\tau = I\alpha \Rightarrow Fr = I\frac{a}{r} \Rightarrow (T_1 - T_2)r = I\frac{a}{r}$

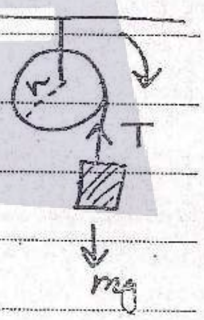
$(50 - 15a)(0.15) = \frac{(0.0225)(a)}{0.15}$

$7.5 - 2.25a = 0.15a$

$7.5 = 2.4a \Rightarrow a = 3.125 \text{ m/s}$

C

[18]: $mg - T = ma \quad \ldots (1)$



$\sum\tau = I\alpha$

$Tr = I\frac{a}{r} \Rightarrow T = \frac{Ia}{r^2} \quad \ldots (2)$

$mg - \frac{Ia}{r^2} = ma$

$mg = a\left(m + \frac{I}{r^2}\right)$

$(3.63)(9.8) = a\left(3.63 + \frac{2.7}{0.61^2}\right)$

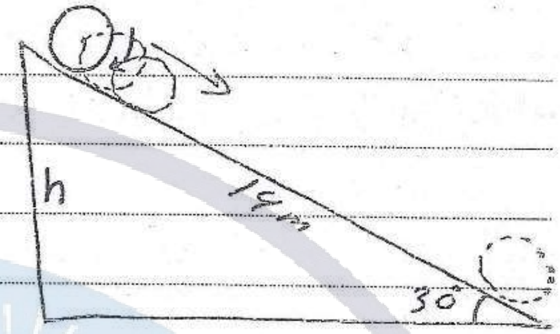
$35.57 = 10.88a$

$a = 3.26 \text{ m/s}^2$

a

[19]:

أولاً نجد ارتفاع المستوى



$h = 14 \sin 30 = (14)(0.5)$

$h = 7\,m$

ثم نجد I عن طريق تطبيق

$I = 0.4\,MR^2 = (0.4)(0.5)(0.06)^2$

$I = 7.2 \times 10^{-4}\ Kg.m^2$

$W - f_k d = \Delta K_{tra} + \Delta U + \Delta U_s + \Delta K_{rot}$

$0 = (\frac{1}{2} m V_f^2 - 0) + (0 - mgh_i) + (\frac{1}{2} I \omega_f^2 - 0)$

where $\omega_f = \frac{V_f}{r} \Rightarrow \omega_f^2 = \frac{V_f^2}{r^2}$

$0 = (\frac{1}{2})(0.5) V_f^2 - (0.5)(9.8)(7) + (\frac{1}{2})(7.2 \times 10^{-4})(\frac{V_f^2}{0.06^2})$

$0 = 0.25 V_f^2 - 34.3 + 0.1 V_f^2$

$34.3 = 0.35 V_f^2$

$V_f^2 = \frac{34.3}{0.35} = 98 \Rightarrow V_f = 9.9\ m/s$

e

[20]: $I = \sum_i m_i r_i^2 = (3)(2)^2 + (2)(2)^2 + (5)(2)^2 + (4)(2)^2$

$I = 56\ Kg.m^2$

$\omega = 2.83 \Rightarrow K_{rot} = \frac{1}{2} I \omega^2 = (\frac{1}{2})(56)(2.83)^2$

$K_{rot} = 224\ J$

d

[21]: $L_{1i} + L_{2i} = L_{1f} + L_{2f}$ $\Rightarrow I_{disk} = 600$

$(I_{1i} + I_{2i})\,\omega_i = (I_{1f} + I_{2f})\,\omega_f$ $\quad I_{child\,i} = 0$

$(600 + 0)\,2.1 = (600 + 180)\,\omega_f$ $\quad I_{child\,f} = (20)(3)^2$

$1260 = 780\,\omega_f$ $\quad = 180$

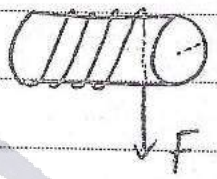
$\omega_f = 1.6\ rad/s$

a

[22]: $\sum \tau = I\alpha$

$Fr = I\alpha \Rightarrow \alpha = \frac{Fr}{I}$

$\alpha = \frac{(2)(0.1)}{(0.02)} = 10 \text{ rad/s}^2$



C

[23] $\vec{L} = \vec{r} \times \vec{p} = \vec{r} \times m\vec{v}$

$\vec{r} = -3i + 2j \qquad m\vec{v} = 3(5i + 3j) = 15i + 9j$

$\vec{r} \times m\vec{v} = \begin{vmatrix} i & j & k \\ -3 & 2 & 0 \\ 15 & 9 & 0 \end{vmatrix} = 0i - 0j + (-27 - 30)k$

$\Rightarrow -57k$

a

[24]: $\omega = 10 \text{ rev/sec} = (10)(2\pi) = 62.83 \text{ rad/sec}$

$\omega = \frac{v}{r} \Rightarrow v = \omega r$

$v = (62.83)(0.2) = 12.6 \text{ m/s}$

b

[25]: $W - f_k d = \Delta K_{tra} + \Delta U_g + \Delta U_s + \Delta K_{Rot}$

$0 = (0 - \frac{1}{2} m v_f^2) + (mgh_i - 0) + (0 - \frac{1}{2} I \omega_f^2)$

$0 = -(\frac{1}{2})(2)(V_f^2) + (2)(9.8)(1.3) - (\frac{1}{2})(80 \times 10^{-3})(\frac{V_f^2}{0.1^2})$

$0 = -V_f^2 + 25.48 - 0.4V^2$

$25.48 = 1.4 V_f^2 \Rightarrow V_f^2 = 18.2 \Rightarrow V_f = 4.3 \text{ m/s}$

b

[26]: $I = \sum_i m_i r_i^2$

$I = mb^2 + mb^2 + mb^2 + mb^2$

$I = 4mb^2$

[27] $\tau_1 = F_1 r \sin\theta = (10)(0.1)\sin 90 = 1 \text{ N.m} \quad (+)$

$\tau_2 = F_2 r \sin\theta = (4)(0.2)\sin 90 = 0.8 \text{ N.m} \quad (-)$

$\tau_3 = F_3 r \sin\theta = (2)(0.2)\sin 90 = 0.4 \text{ N.m} \quad (-)$

$\tau_4 = F_4 r \sin\theta = \text{zero}$

$\sum \tau = 1 + (-0.8) + (-0.4) + (0) = -0.2 \text{ N.m}$

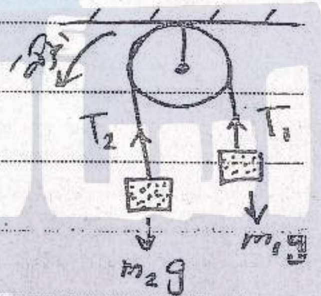
a

[28]: $m_2 g - T_2 = m_2 a$

$2g - T_2 = 2a \Rightarrow T_2 = 2g - 2a \ldots ①$

$T_1 - m_1 g = m_1 a$

$T_1 - g = a \Rightarrow T_1 = g + a \ldots ②$



$T_2 - T_1 = g - 3a$

$\sum \tau = I\alpha \Rightarrow (T_2 - T_1) r = I \dfrac{a}{r}$

$(g - 3a)(1) = \dfrac{(5)(a)}{1} \Rightarrow g - 3a = 5a$

$g = 8a \Rightarrow a = \dfrac{g}{8} \text{ m/s}^2$

a

[29]: $W - f_k d = \Delta K_{tra} + \Delta U_g + \Delta U_s + \Delta K_{Rot}$

$0 = (\frac{1}{2} m V_f^2 - 0) + (mgh_f - mgh_i) + (\frac{1}{2} I \omega_f^2 - 0)$

$0 = \frac{1}{2} m V_f^2 + (mgR - mg3R) + (\frac{1}{2} \frac{2}{5} m r^2 \frac{V_f^2}{r^2})$

$0 = 0.5 m V_f^2 - 2mgR + 0.2 m V_f^2$

$2mgR = 0.7 m V_f^2$

$V_f^2 = \dfrac{2gR}{0.7} \Rightarrow V_f = \sqrt{\dfrac{2gR}{0.7}}$

$V_f = \sqrt{\dfrac{20gR}{7}} \text{ m/s}$

b