physic 101

في كلّ يومٍ ننمو يُورِق عِلمٌ تُزهِر فكرَة

Ch. 1

Units, Physical Quantities, and Vectors

الطالبة : وجد عبدالله الحرشني

Example 1:

A car is traveling at 20 m/s. The speed of this car is equivalent to:

Solution :

$$\frac{\mathbf{20 \times 10^{-3}}}{\left(\frac{\mathbf{1}}{\mathbf{3600}}\right)}$$

= 72 km/h

Example 2:

A cube of edge 47.5 mm, its volume is:

Solution :

$$V = L^3$$

تحويل $47.5 \times 10^{-3} = 0.0475m$

$$(0.0475^3) = 1.072 \times 10^{-4}\ m^3$$

Example 3:

A train moves with a speed of 65 mile per hour. The speed in SI units is: (Hint: 1 mile = 1610 m)

Solution :

$$65 \times \frac{1610}{3600} = 29 m/s$$

Example 4:

Which of the following quantities is not a vector quantity?

A) **Velocity**
B) **Mass**
C) **Acceleration**
D) **Force**

Solution :

Mass

Example 5:

The component of vector $\vec{A}$ are given as $A_x = 5.5\ m$ and $A_y = -5.3\ m$. The magnitude of vector $\vec{A}$ is:

Solution :

$$|A| = \sqrt{(5.5)^2 + (-5.3)^2}$$

$$= 7.6\text{m}$$

Example 6:

In figure, if $\vec{A}+\vec{B}-\vec{C}=4\hat{i}$ then the vector $\vec{A}$ in unit vector notation is:

Solution :

C = 6i

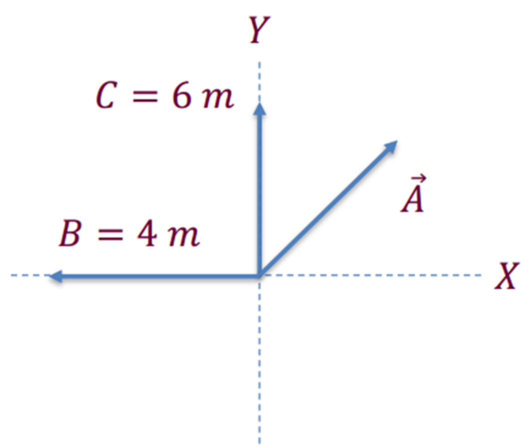
B = -4i

A+B-C= 4i

A-4I-6J=4i

A = 4i +4i -6j

= 8i + 6j



Example 6:

Given $\vec{A} = \hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{B} = 2\hat{i} - 3\hat{j} + 4\hat{k}$, then $(\vec{A} \cdot \vec{B})$ is:

Solution :

$$(\vec{A}.\vec{B})$$

$$=(i+2j+3k).(2i-3j+4k)$$

$$= 2 - 6 + 12 = 8$$

Example 7:

Given $\vec{A} = 2\hat{i} + \hat{j} + 3\hat{k}$, $\vec{B} = 2\hat{i} - 6\hat{j} + 7\hat{k}$, $\vec{C} = 2\hat{i} - \hat{j} + 4\hat{k}$ then the vector $\vec{D} = 2\vec{A} + \vec{B} - \vec{C}$ is:

Solution :

2A=4i+2j+6k

D=2A+B-C

= (4i+2j+6k)+(2i-6j+7k)+(-2i+j-4k)

=4i-3j+9k

Example 8:

Refer to Example 7, the angle between the vector $\vec{A}$ and the positive z-axis is:

Solution :

$$\mathbf{A = 2i + j + 3k}$$

$$|A| = \sqrt{2^2 + 1^2 + 3^2} = \sqrt{14} = 3.74$$

$$\alpha z = |\alpha| \cos\theta$$

$$\theta = \cos^{-1}\frac{3}{3.74} = 36.7°$$

Example 9:

The result of $\hat{i} \cdot \hat{j}$ is:

Solution :

ZERO

" لأنها مختلفة "

Example 10:

If $\vec{A}$ and $\vec{B}$ are vectors with magnitudes 5 and 4 respectively, and the magnitude of their cross product is 17.32, then the angle between $\vec{A}$ and $\vec{B}$ is:

Solution :

$$A \times B = Ab \sin\theta$$

$$17.32 = 20 \sin \theta$$

$$\sin\theta = \frac{17.32}{20} = 0.866$$

$$\theta = sin^{-1}(0.866) = 60°$$

Example 11:

Given that $\vec{A} = \hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{B} = 2\hat{i} - \hat{j} + 4\hat{k}$, then $(\vec{A} \times \vec{B})$ is:

Solution :

$(A\times B) = -1(i\times j)+4(i\times k)+4(j\times i)+8(j\times k)+6(k\times i)-3(k\times j)$

$= -1k -4j -4k +6j +3i$

$=11i + 2j -5k$

Example 12:

If $\vec{A} \times \vec{B} = 0$, the angle between the vectors $\vec{A}$ and $\vec{B}$ is:
(Hint: $\vec{A}$ and $\vec{B}$ are non-zero vectors)

Solution :

A.B = 0	A×B = 0
$\theta = 90$	$\theta = 0$

Zero

Example 13:

The result of $(\hat{i} \times \hat{j}) \cdot \hat{j}$ is:

Solution :

$$(\mathbf{i} \times \mathbf{j}) . \mathbf{j}$$
$$= \mathbf{k} . \mathbf{j}$$
$$= 0$$

Example 14:

The result of $(\hat{i} \times \hat{j}) \times \hat{i}$ is:

Solution :

$$(i \times j) \times i$$

$$\downarrow$$

$$K \times i$$

$$= j$$

Ch. 2

Motion along a Straight Line

الطالبة : رزان حاسن العسمي

Example 1:

A bicycle travels 12 km in 90 min. Its average speed is:

Solution

$$S = \frac{total\ distance}{\Delta t}$$

$$S = \frac{12}{1.5} = 8\ km/h$$

$$Min \xrightarrow{\div 60} h$$

$$t = \frac{90}{60} = 1.5\ h$$

$$td = 12\ km$$

Example 2:

The position of a particle moving on an x axis is given by $x = 4 + 7t - t^2$, with x in (m) and t in (s). The velocity at 3 s is:

Solution

$X=4+7t-t^2$

اشتقاق → $V=7-2t$

$V=7-2(3)$ $t = 3$

$V= 1 m/s$

Example 3:

A car uniformly changes its speed from 20 m/s to 5 m/s in 5 s. The average acceleration is:

Solution

$$a_{ave} = \frac{V_2 - V_1}{t_2 - t_1}$$

$$a_{ave} = \frac{5 - 20}{5}$$

$$a_{ave} = -3\ m/s^2$$

Example 4:

The velocity of a train is given by $v(t)=98-3t$, (where t in seconds and v is in m/s), has an acceleration of:

Solution

V = 98-3t

اشتقاق → a= -3 m/s^2

Example 5:

A particle starts motion at 15 m/s. If it moves 20 m in 2 s, its final velocity is:

Solution

$x = \frac{1}{2}(V + V_0)t$

$20 = \frac{1}{2}(V+15)2$

$V = 20-15=5$ m/s

$V_0 = 15$ m/s

$X = 20$ m

$t = 2$ s

$V = ?$

Example 6:

A car takes 10 s to accelerate from 0 to 50 m/s with constant acceleration. This acceleration is:

Solution

$V = V_0 + at$

$50 = 0 + 10a$

$a = 5\ m/s^2$

$V_0 = 0\ m/s$

$V = 50\ m/s$

$t = 10\ s$

$a = ?$

Example 7:

A train changes its velocity from 70 km/h to 20 km/h in 6 s. The distance it covered is:

Solution

$$\Delta x = \frac{1}{2}(V + V_0)t$$

$$\Delta x = \frac{1}{2}(5.56 + 19.44)6$$

$$\Delta x = 75 \text{ m}$$

$$V_0 = 70 \times \frac{1000}{3600} = 19.44 \text{ m}/s$$

$$V = 20 \times \frac{1000}{3600} = 5.56 \text{ m}/s$$

$t = 6$ s

$\Delta x = ?$

Example 8:

A car moves along the x-axis with constant speed, the acceleration of the car is:

Solution

Constant speed   سرعة ثابتة :

$a = 0$ التسارع = صفر

Example 9:

A ball is thrown vertically upward at a speed of 12 m/s. It will reach its maximum height in:

Solution

$V = V_0 - g\,t$

$12 = 0 - 9.8t$

$t = \frac{12}{-9.8} = -1.22\ s = 1.22\ s$

$V_0 = 0\ m/s$

$V = 12 m/s$

$t = ?$

ملاحظة /

الزمن لا يكون سالب.

Example 10:

A stone is dropped vertically downwards from a height h. If the stone reaches a height of 10 m above the ground in 2 s, the height h is:

Solution

$Y - Y_0 = V_0 t - \frac{1}{2} g t^2$

$10 - h = 0 - \frac{1}{2}(9.8)(2)^2$

$-h = -19.6 - 10$

$h = 29.6$ m

$V_0 = 0$ m/s

$y = 10$ m

$t = 2$ s

$h = ?$

Example 11:

A boy shot a foot ball vertically up with an initial speed v_0. When the ball was 2 m above the ground, the speed was 0.4 of the initial speed. The initial speed is:

Solution

$V^2 = V_0^2 - 2gy$

$(0.4V_0)^2 = V_0^2 - 2(9.8)(2)$

$0.16V_0^2 = V_0^2 - 39.2$

$0.16V_0^2 - V_0^2 = -39.2$

$0.84\ V_0^2 = -39.2$

$V_0^2 = 46.7$

$V_0 = \sqrt{46.7}$

$V_0 = 6.83$ m/s

ملاحظة /
المسافة لا يمكن ان تكون سالبة .

Ch. 3

Motion in Two or Three Dimensions

الطالبة : رغد حامد الحمراني

Example 1:

A particle moving from $\vec{r_1} = 2\hat{i} + 5\hat{j} + 8\hat{k}$ to $\vec{r_2} = 12\hat{i} + 10\hat{j} + 8\hat{k}$, then the displacement is:

Solution :

$$\Delta\vec{r} = \vec{r}_2 - \vec{r}_1.$$

$$= (12 - 2)\hat{\imath} + (10 - 5)\hat{\jmath} + (8 - 8)\hat{k}$$

$$= 10\hat{\imath} + 5\hat{\jmath}$$

Example 2:

A particle moves in xy plane as x(t) = 2t (m) and y(t) $= t^2 - 1\ (m)$. The velocity of the particle at t=1 s is:

Solution :

$$\vec{v} = \frac{d\vec{r}}{dt}.$$

نشتق المعادلة الخاصة بالمحور (x) و هي x(t) = 2t عندما t = 1s

$$v_x = \frac{dx}{dt} = 2 = 2\,\hat{\imath}$$

نشتق المعادلة الخاصة بالمحور (y) و هي y(t) = t^2 - 1 عندما t = 1s

$$v_y = \frac{dy}{dt} = 2t = 2\,\hat{\jmath}$$

$$\mathcal{V} = v_x\,\hat{\imath} + v_y\,\hat{\jmath}$$

$$= 2\,\hat{\imath} + 2\,\hat{\jmath}\ \text{m\textbackslash s}$$

Example 3:

At t=0, a car moves with velocity $\overrightarrow{v_0} = 2\hat{\imath} + \hat{\jmath}$ (m/s) and acceleration $\vec{a} = 2\hat{\jmath}$ (m/s^2). The velocity of the car at t=2 is:

Solution :

$$\vec{a}_{avg} = \frac{\vec{v}_2 - \vec{v}_1}{\Delta t} = \frac{\Delta \vec{v}}{\Delta t}.$$

$$2\hat{\jmath} = \frac{v_2 - (2\hat{\imath} - 2\hat{\jmath})}{2-0}$$

$$v_2 = 4\hat{\jmath} + 2\hat{\imath} + \hat{\jmath}$$

$$v_2 = 2\hat{\imath} + 5\hat{\jmath}$$

Example 4:

A boy kicks a ball at an angle of 40^0 to the horizontal with speed of 14.0 m/s. The time it takes to reach the highest point is:

Solution :

نستنتج من السؤال أن :

θ	v_0	v_y	t
40°	14.0 m\s	0	?

حسب المعطيات نستخدم القانون التالي :

$$v_y = v_0 \sin \theta_0 - gt,$$

$$v_y = v_0 \sin \theta_0 - gt,$$

$$0 = (14.0) \sin 40 - (9.8)t$$

$$0 = 8.9 - 9.8\,t$$

$$t = 0.92\ s$$

Example 5:

A boy kicks a ball at an angle of 40^0 to the horizontal with speed of 14.0 m/s. The maximum height that the ball can reach is:

Solution :

نستنتج من السؤال أن :

θ	v_0	v_y	t	y_{max}
40°	14.0 m\s	0	0.92	?

حسب المعطيات نستخدم القانون التالي :

$$y - y_0 = (v_0 \sin \theta_0)t - \frac{1}{2}gt^2,$$

$$y - y_0 = (v_0 \sin \theta_0)t - \frac{1}{2}gt^2,$$

$$y_{max} - 0 = (14 \sin 40)(0.92) - \frac{1}{2}(9.8)(0.92)^2$$

$$y_{max} = 4.13 \text{ m}$$

Example 6:

Referring to question 5, the horizontal range that the ball can reach is:

Solution :

$$R = \frac{v_0^2}{g} \sin 2\theta_0.$$

$$= \frac{(14)^2}{9.8} \sin 2\,(40)$$

$$= 19.7 \text{ m}$$

Example 7:

A projectile is launched to achieve a maximum range of 140 m, the speed of the projectile must be:

The horizontal range *R* is maximum for a launch angle of 45°.

Solution :

* ملحوظة : نستنتج من maximum Range أن $\theta = 45°$

$$R = \frac{v_0^2}{g} \sin 2\theta_0.$$

$$140 = \frac{v_0{}^2}{9.8} \sin 2(45)$$

$$v_0 = \sqrt{(140)(9.8)} = 37 \text{ m/s}$$

Example 8:

A toy car runs on a horizontal table with 3 m/s. The angle it makes with the horizontal when it leaves the table is:

Solution :

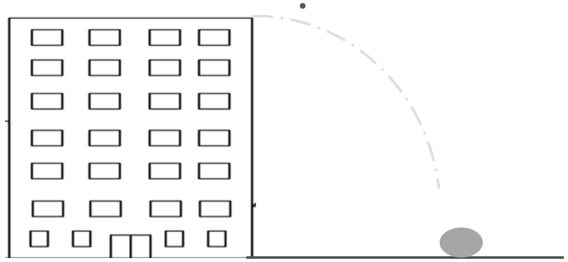
zero

Example 9:

A stone is thrown horizontally from the top of a tall building. It follows a path that is:

Solution :

رسم توضيحي :



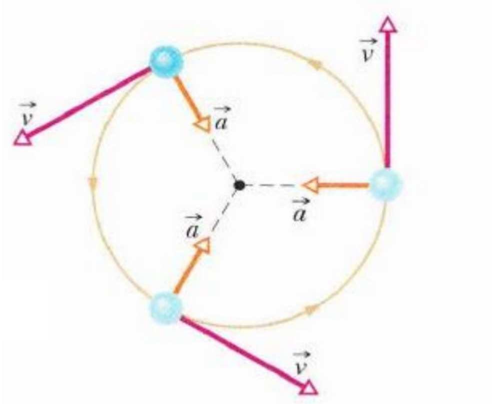
parabolic

Example 10:

The velocity and acceleration of a body in a uniform circular motion are:

Solution :

perpendicular



Example 11:

A car rounds a 20 m radius curve at 10 m/s. The magnitude of its acceleration is:

Solution :

$$a = \frac{v^2}{r}$$

$$a = \frac{(10)^2}{20}$$

$$= 5\ \text{m}\backslash s^2$$

Example 12:

A truck is traveling with a constant speed of 20 m/s. When the truck follows a curve in the road, its centripetal acceleration is 4.0 m/s^2. The radius of the curve is:

Solution :

$$a = \frac{v^2}{r}$$

$$4 = \frac{(20)^2}{r}$$

r = 100 m

Ch. 4

Newton’s Laws of Motion

الطالبة : إيناس صابر الحربي

Example 1:

A car travels east at constant velocity. The net force on the car is:

Solution

Zero

Newton's first of law,

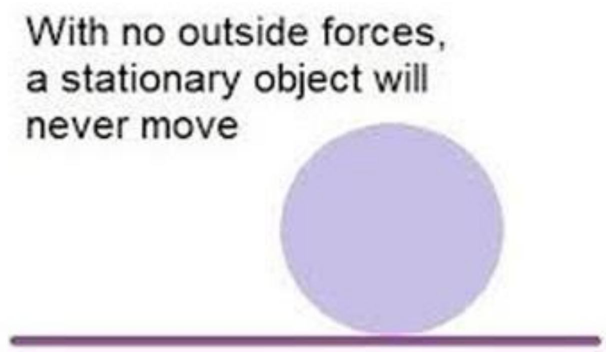
Example 2:

A 3 kg box is moving with a constant speed. The net force on the box is:

<u>*Solution*</u>

Zero

Newton's first of law,



Example 3:

Two forces are applied to an object of mass 18.25 kg. One force is 27.5 N to the north and the other is 24.0 N to the west. The magnitude of the acceleration of the object is:

Solution

$$a = \frac{\in F}{m} = \frac{F_1+F_2}{m} = \frac{-24i+27.5\,j}{18.25}$$

$$a = -1.32i+1.5j$$

$$|a| = \sqrt{1.322+1.52} = 2$$

$F_1 = 27.5\ j$

$F_2 = -24i$

$m = 18.25\ kg$

Example 4:

Three forces act on a particle in which it moves with constant speed, if $\overrightarrow{F_1} = (-8\hat{i})$N and $\overrightarrow{F_2} = (-10\hat{j})$N. Then $\overrightarrow{F_3}$ is:

Solution

$F_{net} = ma$, $a=0$

$F_{net}=0$

$\overrightarrow{F}_1+\overrightarrow{F}_2+\overrightarrow{F}_3=0$

$-8i-10j+\overrightarrow{F}_3$

$\overrightarrow{F}_3=8i+10j$

Example 5:

A 60 kg person weighs 100N on the moon. The acceleration of gravity on the moon is:

Solution

$$g = \frac{w}{m}$$

$$g = \frac{100}{60} = 1.67\ m/s^2$$

Example 6:

A man of mass 50 kg. His weight is:

Solution

Ws=mg

50x9.8

= 490N

Ch. 5

Applying Newton’s Laws

الطالبة : نجود البلادي

Example 1:

A cable hold a ball of weight 250 N in static equilibrium. The tension in the cord is:

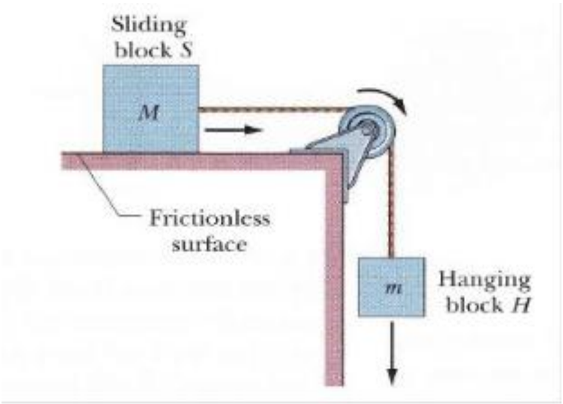
Solution

T=w

=250 N

Example 2:

In the figure, M=2.5 kg is on a horizontal frictionless surface and m=1.5 kg is hanging. The acceleration of the blocks is:



Solution:

$$a = \frac{\text{m}}{m_1 + m_2} \times g$$

$$a = \frac{1.5}{2.5+1.5} \times 9.8$$

$$a = 3.675 \text{ m}/s^2$$

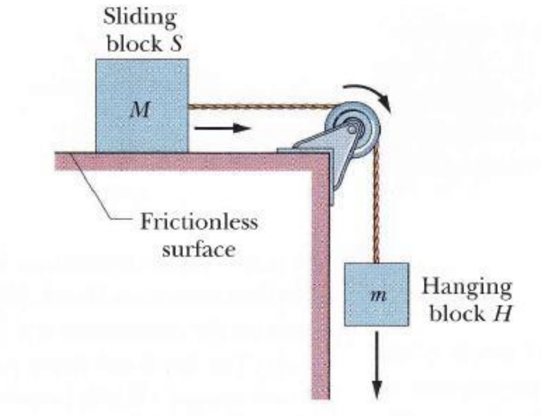
Example 3:

Refer to Example 2, the tension in the cord is:

Solution:

$T = Ma$

$T = 2.5 \times 3.675 = 9.19N$



Example 4:

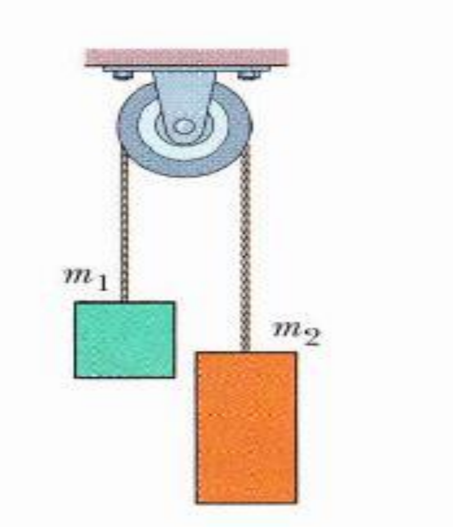
In the figure, two blocks connected together with cord over a pulley where m_1=2 kg and m_2 =3 kg. The acceleration of the blocks is:

Solution:

$$a = \frac{m2 - m1}{m1 + m2} \times g$$

$$a = \frac{3-2}{3+2} \times 9.8$$

$$a = 1.96 m/s^2$$



Example 5:

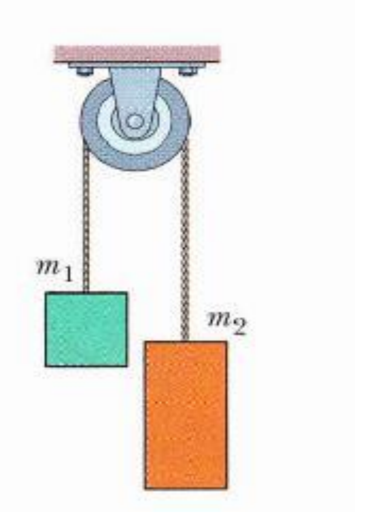
Refer to Example 4, the tension in the cord is:

Solution:

$T = m_1(g + a)$

T =2(9.8+1.96)

T =23.52 N



Example 6:

In the figure a 10 kg box is pushed at a constant speed up the frictionless ramp by a horizontal force F. the magnitude of F is:

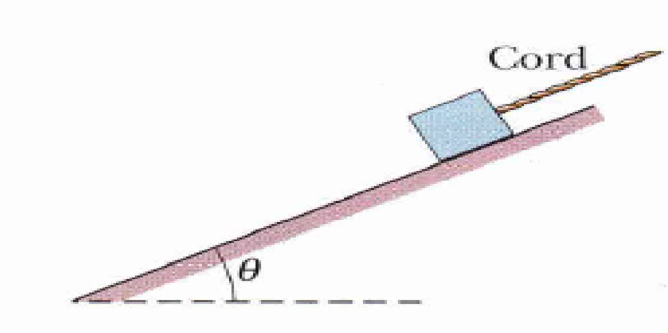
Solution:

g=9.8 , $\theta = 30$

F=mg sin θ

F=10× 9.8 sin(30)

F=49 N



Example 7:

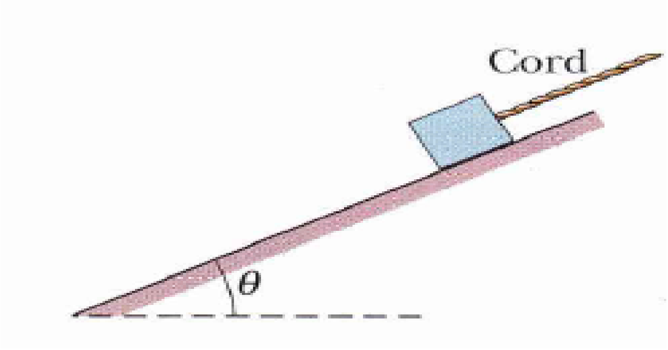
Refer to Example 6, the normal force on the box is:

Solution:

$N = mg\cos\theta$

$N = 10 \times 9.8\cos(30)$

N=84.87N



Example 8:

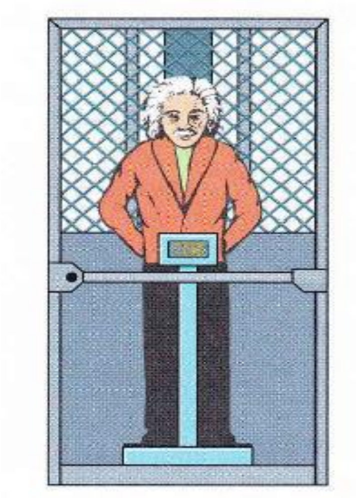
A 1000 kg elevator is moving up with acceleration 3 m/s^2. The tension in the cable is:

Solution:

$T = m(g + a)$

$T = 1000(9.8+3)$

$T = 12800$ N



Example 9:

Two blocks (A and B) are in contact on a horizontal frictionless surface. A 50 N constant force is applied to B as shown. The tension in the cord is:

Solution

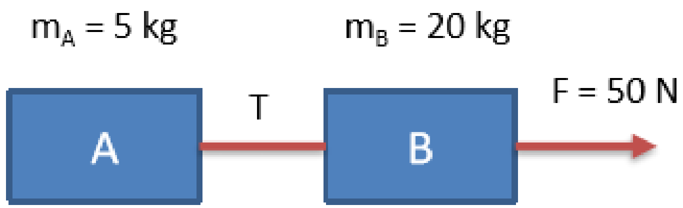
F $=(m_{1+m_2})a$

$50=(5\times 20)a$

$a = 2\ m/s^2$

T $= \ m_A \times a$

T $=5\times 2 = 10\ N$



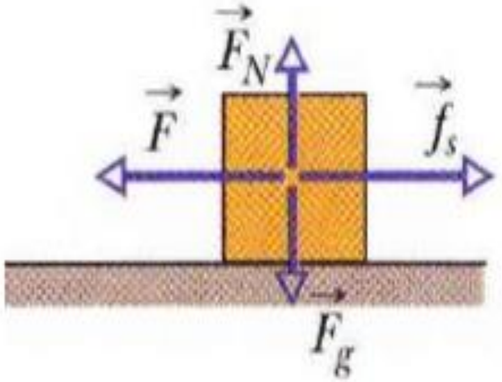
Example 10:

The fractional force on a moving body is proportional to the:

Solution:

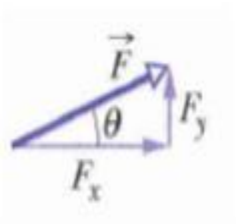
$F_{k=uk-N}$

normal force on the body



Example 11:

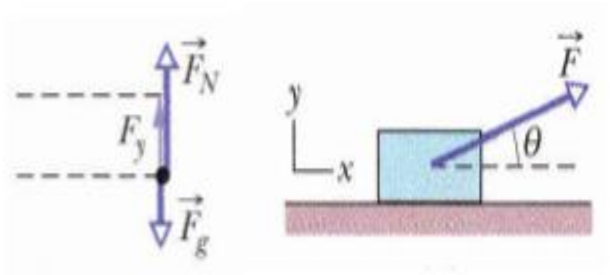
A boy pulls a wooden box along a rough horizontal floor at constant speed. Which of the following must be true?

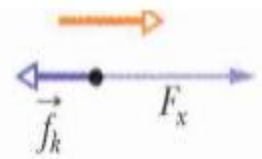


Solution:

$* \; F_k = F\cos\theta$

$* \; N + F\sin\theta = W$





Example 12:

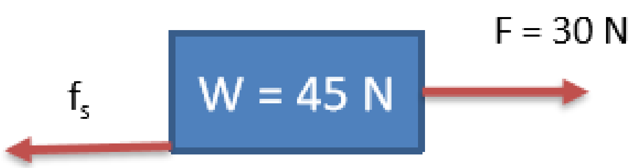
A block slide on a rough surface (see figure). The block start to slide when a parallel force of 30 N is applied. The coefficient of static friction μ_s is:

Solution:

$$\mu_s = \frac{f_s}{N}$$

$$\mu_s = \frac{F}{mg} = \frac{30}{45}$$

$$\mu_s = 0.67$$



Example 13:

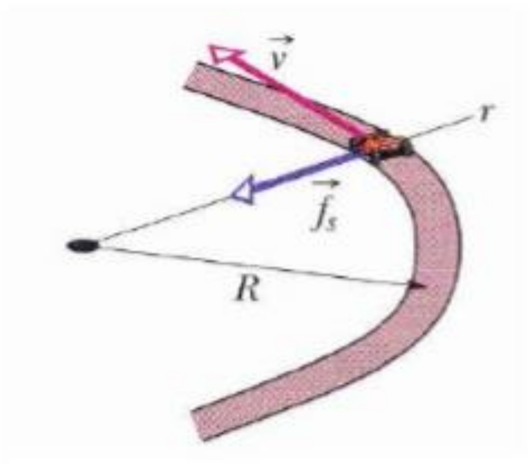
A car has mass of 1700 kg is moving with a constant speed of 25 m/s in a circular track of a radius 200 m. The car tires static friction coefficient with the road is:

Solution:

$V = \sqrt{\mu s \times R \times g}$

$25 = \sqrt{\mu s \times 200 \times 9.8}$

s =0.32μ



Ch. 6

Work and Kinetic Energy

الطالبة : لولوة الصنعاني

Example 1:

A particle moves 10 m in the positive x direction while being acted upon by a constant force $\vec{F} = (4\hat{i} + 4\hat{k})$N. The work done on the particle by this force is:

Solution:

$$\vec{F} = (4\hat{\imath} + 4\hat{K})N$$

$$\vec{d} = (10\hat{\imath})m$$

$$W = \vec{F} \cdot \vec{d}$$

$$= \left(4\hat{\imath} + 4\hat{K}\right) \cdot 10\hat{\imath} = 40\hat{\imath} + 0 = 40\ J$$

Note: $\hat{\imath} \cdot \hat{k} = 0$

Example 2:

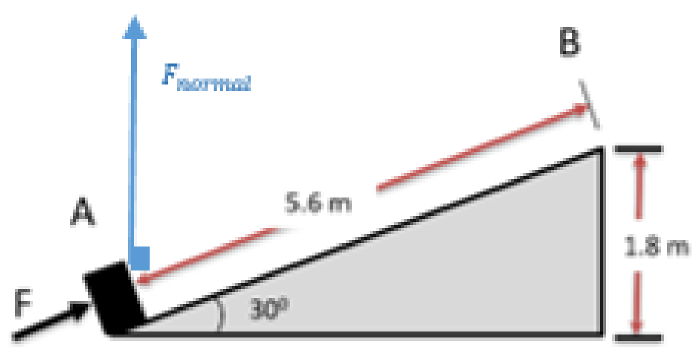
A force F causes the 2 kg box to slide up from point A to point B. The work done by the normal force on the box is:

<u>Solution:</u>

$W = \vec{F} \cdot \vec{d} \cos\theta$

$\theta = 90$

$\cos\theta = zero$

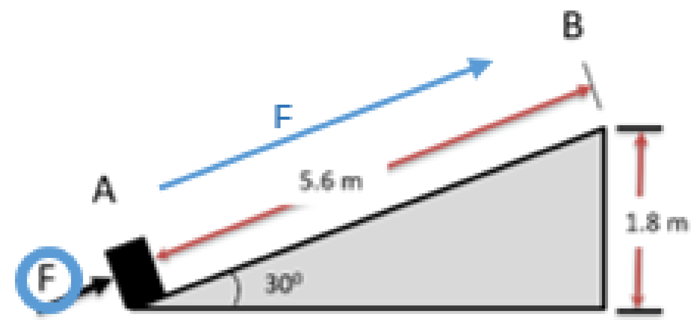


Example 3:

Referring to Example 2, if F=100 N and the distance between point A to point B is 5.6 m, the work done by the applied force on the box is:

Solution:

d and **F** in the same direction if the angle



Example 4:

An object that has kinetic energy must be:

Solution:

Kinetic Energy K is energy associated with the state of motion of an object. The faster the object moves, the greater its kinetic energy.

Example 5:

A moving particle of mass 2 kg, has kinetic energy of 10 J. It speed is:

Solution:

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

$$10 = \frac{1}{2}2v^2$$

$$10 = v^2$$

$$v = 3.16\, m/s$$

Example 6:

A 4 kg cart starts up an incline with a speed of 3 m/s and comes to rest 2 m up the incline. The total work done on the cart is:

Solution:

$$\Delta K = K_f + K_i = W$$

$$W = \frac{1}{2}mv_f^2 + \frac{1}{2}mv_i^2$$

$$= \left(\frac{1}{2}(4)(0)^2\right) + \left(\frac{1}{2}(4)(3)^2\right) = 0 - 18$$

$$= -18J$$

Example 7:

A man of mass 102 kg climbs a stair of 5 m height at constant speed. The work done by the man is:

Solution:

$W = mgd\cos\theta$

$W = (102)(9.8)(5)\cos 0 = 4998\, J$

Example 8:

If the restoring force at distance 0.5 m is 15 N, then the work done in stretching spring a distance of 0.5 m is:

Solution:

Step1: find kinetic energy K

using $F_x = -kx$

$$K = \frac{F_x}{x} = \frac{15}{0.5} = 30$$

Step2: $W_s = -\frac{1}{2}Kx_f^2$

$$W_s = -\frac{1}{2}(30)(0.5)^2 = -3.75\,J$$

Example 9:

A force acts on a spring with length 30 cm. This force compressed it to be 25 cm. If the spring constant is 50 N/m, the work done by the spring is:

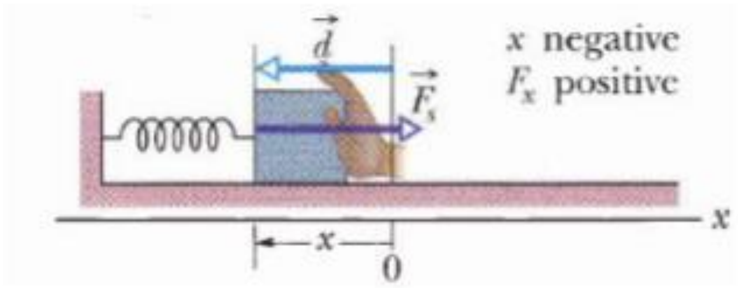
Solution:

$x_f = (30 \times 10^{-2}) - (25 \times 10^{-2})$

$= 0.05\, m$

$W_s = -\frac{1}{2} K x_f^2$

$= -\frac{1}{2}(50)(0.05^2) = -0.0625\, J$



Example 10:

If the work done on a particle is 32 J in 4 s. The power is:

Solution:

$$P = \frac{W}{t} = \frac{32}{4} = 8\ W$$

Example 11:

A box was pushed 3 m across the floor in 12 s by a horizontal force of 200 N. The amount of power is:

Solution:

$$P = \frac{W}{t} = \frac{Fd}{t} = \frac{(3)(200)}{12}$$
$$= 50\ W$$

$$W = Fd$$

Ch. 7

Potential Energy and Energy Conservation

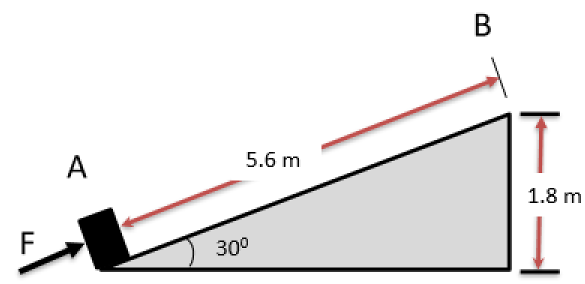
الطالبة : لولوة الصنعاني

Example 1 :

A force F causes the 2 kg box to slide up from point A to point B. The gravitational potential energy gained by the box is:

Solution:

$$U = mgy$$
$$U = (2)(9.8)(1.8)$$
$$U = 35.28\ J$$



Example 2:

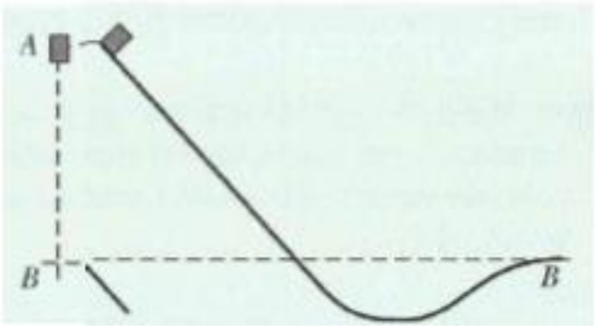
In a sliding game at a fun fair, a child train was sliding in different heights. If the train slipped from height A 10 m till height B 7 m. The speed of the train at point B is

Solution:

$$V_2 = \sqrt{2g(y_2 - y_1)}$$

$$= \sqrt{2(9.8)(10-7)}$$

$$= 7.67 \text{ m/s}$$



Ch. 8

Momentum, Impulse and Collisions

رغد الحمراني – رزان العسمي – إيناس الحربي

Example 1:

A force was applied on an object of mass 50 kg which changed its speed from 13 m/s to 45 m/s. The momentum for each speed is:

Solution :

$$\vec{p} = m\vec{v}$$

p_1 = m v_1= (50)(13) = 650 Kg.m\s

p_2 = m v_2= (50)(45) = 2250 Kg.m\s

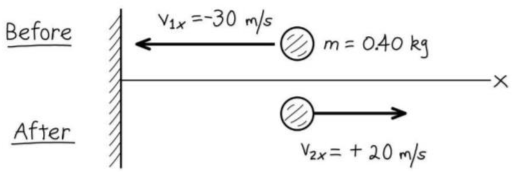
Example 2:

A 0.40 kg ball is initially moving to the left at 30 m/s. After hitting the wall, the ball is moving to the right at 20 m/s. The impulse of the net force on the ball during its collision with the wall is:

Solution :

$$\Delta\vec{p} = \vec{J}$$

$$J = \Delta p = p_2 - p_1$$
$$= m\, v_2 - m\, v_1$$
$$= m\,(20 - (-30))$$
$$= 0.4\,(20+30)$$
$$= 20 \text{ kg.m}\backslash\text{s}$$



Example 3:

During a collision with a wall, the velocity of a 0.200-kg ball changes from 20 m/s toward the wall to 12.0 m/s away from the wall. If the time when the ball was in contact with the wall is 60.0 ms, the magnitude of the average force applied to the ball is

Solution :

$$F_{avg} = \frac{\Delta P}{\Delta t} = \frac{m(v_2 - v_1)}{60\times10^{-3}} = \frac{0.2(12-(-20))}{60\times10^{-3}} = 107\ \text{N}$$

Example 4:

A time-varying horizontal force $F(t) = 4.5t^4 + 8.75t^2$ acts for 0.500 s on a 12.25-kg object. The impulse imparted to the object by this force is:

Solution :

$$J = F_{avg}\,\Delta t.$$

$$F(t) = 4.5t + 8.75t$$

F(0) = 0

F(0.5) = 2.4 N

$$F_{avg} = \frac{F_1 + F_2}{2} = \frac{0+2.4}{2} = 1.23\ \text{N}$$

$= 1.23(0.5 - 0)$

=0.62 N.S

Example 5:

On a smooth horizontal frictionless floor, an object slides into a spring which is attached to another stationary mass. Afterward, both objects are moving at the same speed. What is conserved during this interaction?

Solution :

Momentum and mechanical energy

Example 6:

A baseball is thrown vertically upward and feels no air resistance. As it is rising

Solution :

Momentum not conserved, but mechanical energy conserved.

Example 7:

A 1.2-kg spring-activated toy bomb slides on a smooth surface along the x-axis with a speed of 0.50 m/s. At the origin 0, the bomb explodes into two fragments. Fragment 1 has a mass of 0.40 kg and a speed of 0.90 m/s along the negative y-axis. In the figure, the angle θ, made by the velocity vector of fragment 2 and the x-axis, is closest to

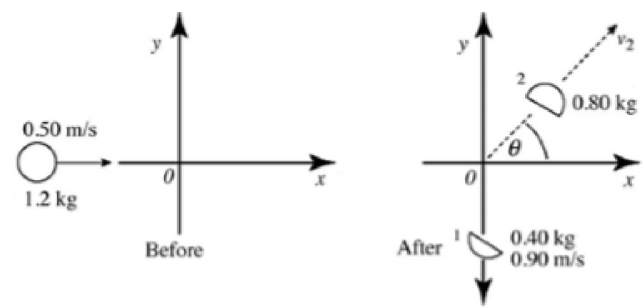
Solution

$P_{before} = P_{after}$

$$\frac{0.45 = V2\ sin}{0.75 = V2\ cos}\ tan\ \frac{0.45}{0.45} = \tan^{-1}(0.6)$$

$$\tan^{-1}(0.6) = 30.9 = 31°$$

For x- axis	For y-axis
$P_{bx}=P_{ax}$	$F_{by}=F_{ay}$
$mv=m_1v_1+m_2v_2$	$0=m_1V_1+m_2V_2$
$(1,2)(0,5)=0+(0,8)(V_2cos)$	$0=(-0.4x0.9)(0.8V_2sin)$
$\frac{0.6}{0.8} = \frac{0.8v2\ cos}{0.8}$, $0.75=V_2cos$	$\frac{0.36}{0.8} = \frac{0.8v2sin}{0.8}$, $0.45 = v2\ sin$



Example 8:

Two objects of the same mass move along the same line in opposite directions. The first mass is moving with speed v. The objects collide, stick together, and move with speed 0.100v in the direction of the velocity of the first mass before the collision. What was the speed of the second mass before the collision?

Solution

$mv_1+mv_2=(m_1+m_2)v$

$mv-mv_2=2m(0.1v)3$

$-v=0.2v-v$

$V+v_2=0.2v$

$V_2=0.2v$

Example 9:

Two gliders with different masses move toward each other on a frictionless air track. The gliders are equipped so that they stick together when they collide. Find the common final x-velocity?

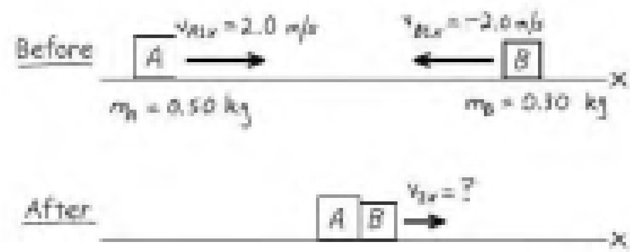
Solution

$m_aV_a+m_bV_b=m_{ab}$

$(0.5x2)+(0.3x-20=0.8V_{ab}$

$1-0.6=0.8V_{ab}$

$V_{ab}=5m/s$



Example 10:

Referring to Example 9, compare the initial and final kinetic energies of the system.

Solution

$K_a=\frac{1}{2}(m_a v_{1a}^2)=(0.5)(2)^2=1J$

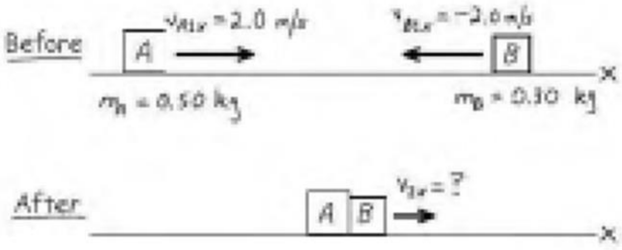
$K_b=\frac{1}{2}(m_b v_{1b}^2)=\frac{1}{2}(0.3)(-2)^2=0.6J$

Total k.E before the concisions

$K_{1before}=k_a+k_b=1+0.6=1.6J$

$K_{2after}=\frac{1}{2}(m_a+m_b)V_{ab}^2=\frac{1}{2}(0.5+0.3)(0.5)^2$

$=0.1 \quad \frac{k2}{k1}=\frac{0.1}{1.6}=\frac{1}{16}$

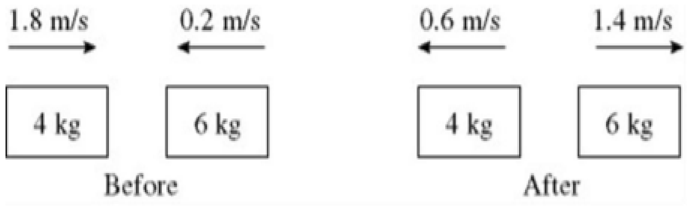


Example 11:

In the figure, determine the character of the collision. The masses of the blocks, and the velocities before and after are given. The collision is

Solution

Perfectly elastic



Example 12:

A 1.0 kg object travelling at 1.0 m/s collides head on with a 2.0 kg object initially at rest. Find the velocity of each object after impact if the collision is perfectly elastic.

Solution

$$V_{2xa} = \frac{Ma - Mb}{Ma + Mb} \; V_{a1x}$$

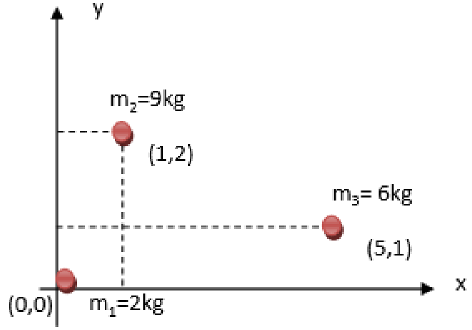
$$= \frac{1-2}{1+2} \times 1 = \frac{-1}{3} m/s$$

$$Vb2x = \frac{2Ma}{Ma + Mb} Va1X$$

$$= \frac{2 \times 1}{1+2} \times 1 = \frac{2}{3} m/s$$

Example 13:

The center of mass of the objects shown in the Figure is:



Solution

$$Xcom = \frac{m1x1 + m2x2}{M}$$

$$X = \frac{2 \times 0 + 9 \times 1 + 6 \times 5}{9 + 6 + 2} = 2.29\text{m}$$

$$g = \frac{2 \times 0 + 9 \times 2 + 6 \times 1}{17} = 1.41\text{m}$$

Example 14:

Three particles as in Fig are initially at rest. experiences an external force. The directions are indicated, and the magnitudes are F1=6.0 N, F_2=12 N, and F_3=14 N. The acceleration of the center of mass of the system is:

Solution

M=4+8+4=16kg

$$a_{com} = \frac{Fnet}{M} = \frac{16.5i + 8.5j}{16}$$

$$= \frac{16.5i}{16} + \frac{8.5j}{16} = 1.03i + 0.53j$$

$$a = \sqrt{(1.03)^2 + (0.53)^2} = 1.16\, m/s$$

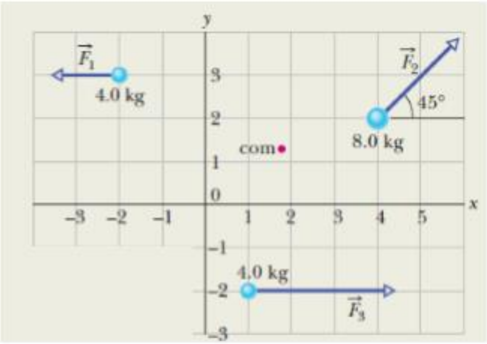
F1=-6i , F2= $(12\cos 45)i + (12\sin 45)$

=8.5i+8.5j

F3=14i

Fnet = (-6+8.5+14)i+8.5j

=16.5i+8.5j



Ch. 9

Rotation of Rigid Bodies

الطالبة : ريناد عثمان الصحفي

Example 1:

A turbine blade of radius 5 cm rotates an angle of 60°. Find the angle of rotation in radians:

المعطى :

The angle = 60°

المطلوب :

Find the angle of rotation in radians .

Solution :

$$60 \times \frac{\pi}{180} = \frac{\pi}{3}$$

Example 2:

A turbine blade of radius 5 cm rotates an angle of 60°. Find the length of scanned arc:

المعطى :

r = 5 cm , the angle is 60° "π/3 تم التحويل في السؤال السابق وتساوي"

المطلوب :

S

Solution :

$$S = \theta \times r$$

$$s = \frac{\pi}{3} \times 5 = 5.23\ cm$$

Example 3:

The angular position θ of a 0.18 m radius flywheel is given by $\theta = 2\ t^3$ rad. Find θ in radians at t = 2 s.

المعطى:

r= 0.18 cm , $\theta = 2\ t^3$

المطلوب :

find θ in radians at t=2 s

solution :

$\theta = 2t^3$= 16 rad

Example 4:

The angular position θ of a 0.18 m radius flywheel is given by $\theta = 2\ t^3$ rad. Find θ in degrees at t = 2 s.

المعطى:

r= 0.18 cm , θ=2 t^3

المطلوب:

find θ in degrees at t=2 s

solution :

1) θ=2t^3= 16 rad

2) $16 \times \frac{180}{\pi} = 917 \approx 920$

Example 5:

The angular position θ of a 0.18 m radius flywheel is given by $\theta = 2\ t^3$ rad. Find the distance that a particle on the flywheel rim moves from $t_1 = 2s$ to $t_2 = 5s$.

r= 0.18 cm , θ=2 t^3 :المعطى

المطلوب:S

Solution:

$$\theta_1 = 2(2)^3 = 16$$

$$\theta_2 = 2(5)^3 = 250$$

$$\Delta\theta = \theta_2 - \theta_1 = 250 - 16 = 234$$

$$s = \theta \times r$$

S=$234 \times 0.18 = 42m$

Example 6:

The angular position θ of a 0.18 m radius flywheel is given by $\theta = 2\ t^3$ rad. Find the average angular velocity over that interval from $t_1 = 2s$ to $t_2 = 5s$.

المعطى:

r= 0.18 cm , θ=2 t^3

المطلوب: w_{av-z}

Solution :

$$\theta = 2(2)^3 = 16$$

$$\theta = 2(5)^3 = 250$$

$$\Delta\theta = \theta_2 - \theta_1 = 250 - 16 = 234$$

$$w_{av-z} = \frac{\Delta\theta}{\Delta t} = \frac{234}{3} = 78$$

Example 7:

The angular position θ of a 0.18 m radius flywheel is given by $\theta = 2\ t^3$ rad. Find the average angular acceleration over that interval from $t_1 = 2s$ to $t_2 = 5s$.

المعطيات:

r= 0.18 cm , θ=2 t^3

المطلوب: α_{av}

Solution :

"من السؤال السابق تم ايجاد w_{av}"

$$\alpha_{av} = \frac{w}{t} = \frac{78}{3} = 26$$

Example 8:

A turbine blade has a radius of 80 cm. At a certain instant, the blade is rotating at 10 rad/s and the angular speed is increasing at 50 rad/s^2. Find the linear speed.

المعطيات :

r=80cm=0,8m , w=10 rad/s

المطلوب:V

Solution :

$V=r\times w$

$V=0.8\times 10=8$

Example 9:

A turbine blade has a radius of 80 cm. At a certain instant, the blade is rotating at 10.0 rad/s and the angular speed is increasing at 50.0 rad/s^2. Find the tangential component of the acceleration.

المعطيات :

r=80cm = 0,8 m , α=50

المطلوب :

a_{tan}

Solution :

$$a_{tan} = r \times \alpha = 0.8 \times 50$$
$$= 40 \ m/s$$

Example 10:

A turbine blade has a radius of 80 cm. At a certain instant, the blade is rotating at 10.0 rad/s and the angular speed is increasing at 50.0 rad/s^2. Find the centripetal component of the acceleration.

المعطيات :

r=80 cm = 0,8 m , w=10

المطلوب :

a_{rad}

Solution :

$$a_{rad} = r \times w^2 = 0.8 \times 10^2 = 80 \text{ m } /s^2$$

Ch. 10

Dynamics of Rotational Motion

الطالبة : ريناد عثمان الصحفي

Example 1:

A plumber stands on the end of the cheater applying 900 N weight at a point 0.80 m from the center of the fitting as shown below. The wrench handle and cheater make an angle of 19^{o} with the horizontal. The magnitude and direction of the torque he applies about the center of the fitting is:

Solution :

T= r F sin Ø

$$\emptyset = (90 + 19) - 180 = 71^{\circ}$$

$T=0.8 \times 900 \sin 71^{\circ} = 680$ n.m

Example 2:

A particle has a mass of 0.25 kg and rotate about a point at distance 3 m with velocity given by $v = 6\,(rad/s^3)\,t^2$. The angular momentum of the particle at t = 3 s is:

Solution :

$$v = 6t^2 \quad at\; t = 3$$

$$= 6(3)^2 = 54\, rad\,/s$$

$$L = 0{,}25 \times 54 \times 3 = 40{,}5$$

Example 3:

Referring to Example 2, the torque of the net force acting on the particle at t = 2 s is:

Solution :

$$0,25\ \times 6\,t^2 \times 3$$

$$L = \frac{dl}{dt} = 0,25\ \times 12t\ \times 3$$

$$= 0,25\,(12 \times 2) \times 3 = 18$$