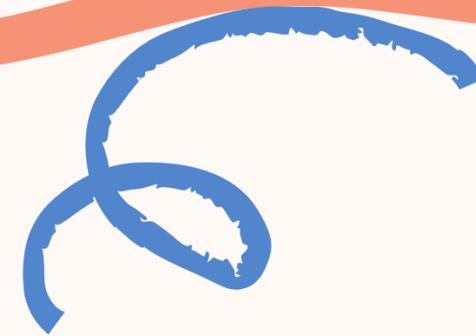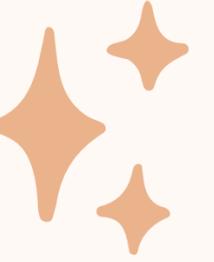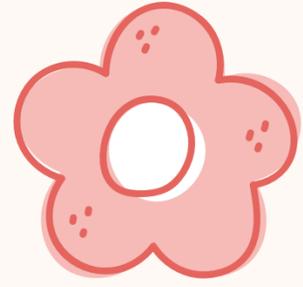# هيكل الفيزياء (الورقي)

11 gen📚
learning channel

Telegram

Relate the arc length (x) to the angular displacement (θ) and the distance (r) from the axis of rotation, relate the linear velocity (v) to the angular velocity (ω) and the distance (r) from the axis of rotation, and relate the linear acceleration (a) to the angular acceleration. (α) and the distance (r) from the axis of rotation .

Table 1 Linear and Angular Measures

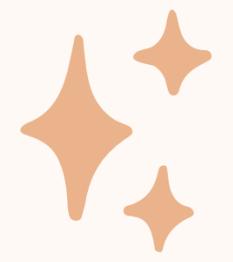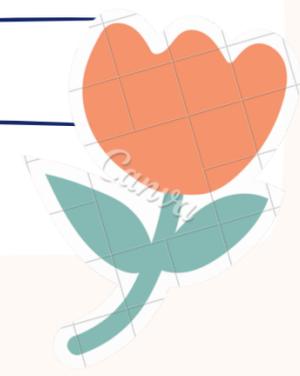| Quantity	Linear	Angular	Relationship
Displacement	x (m)	θ (rad)	$x = r\theta$
Velocity	v (m/s)	ω (rad/s)	$v = r\omega$
Acceleration	a (m/s^2)	α (rad/s^2)	$a = r\alpha$

Relate the arc length (x) to the angular displacement (θ) and thel
distance (r) from the axis of rotation, relate the linear velocity (v)
to the angular velocity (ω) and the distance (r) from the axis of
rotation, and relate the linear acceleration (a) to the angular
acceleration. (α) and the distance (r) from the axis of rotation .

- The distance (x) is measured in meters in this equation: $x = r\theta$.

- If the angular velocity of a body is (ω) .. the linear velocity of a point located at a distance r from the axis
  of rotation is found by the relationship $v = r\omega$.

- If the change in angular velocity is positive + , then the angular acceleration is also positive + .

- The angular acceleration determined in this way is equal to the angular velocity over the time period (t) .

- The linear acceleration (a) of a point is found at a distance (r) from the axis of a body equal to its angular
  acceleration (α) .. $a = r\alpha$.

Apply the relationship between a force F and the work done on a system by the forcewhen the system undergoes a displacement d: $W = Fd \cos\theta$ where θ is the angle between the direction of the force and the direction of displacement .

$$v = \frac{2\pi r}{T} \quad .a_c = \frac{(2\pi r/T)^2}{r} = \frac{4\pi^2 r}{T^2}$$

EXAMPLE 3

UNIFORM CIRCULAR MOTION A 13 g rubber stopper is attached to a 0.93 m string. The stopper is swung in a horizontal circle, making one revolution in 1.18 s. Find the magnitude of the tension force exerted by the string on the stopper.

1 ANALYZE AND SKETCH THE PROBLEM
- Draw a free-body diagram for the swinging stopper.
- Include the radius and the direction of motion.
- Establish a coordinate system labeled *tang* and *c*. The directions of a_c and F_T are parallel to *c*.

KNOWN | **UNKNOWN**
$m = 13$ g | $F_T = ?$
$r = 0.93$ m |
$T = 1.18$ s |
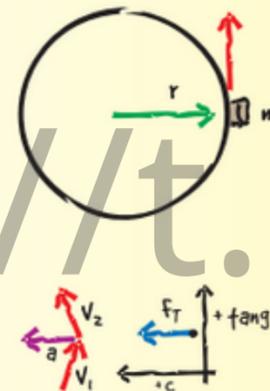
2 SOLVE FOR THE UNKNOWN
Find the magnitude of the centripetal acceleration.

$a_c = \frac{4\pi^2 r}{T^2}$

$= \frac{4\pi^2 (0.93 \text{ m})}{(1.18 \text{ s})^2}$ ◄ Substitute r = 0.93 m, T = 1.18 s.

$= 26$ m/s²

Use Newton's second law to find the magnitude of the tension in the string.
$F_T = ma_c$

$= (0.013 \text{ kg})(26 \text{ m/s}^2)$ ◄ Substitute m = 0.013 kg, a_c = 26 m/s².

$= 0.34$ N

3 EVALUATE THE ANSWER
- **Are the units correct?** Dimensional analysis verifies that a_c is in meters per second squared and F_T is in newtons.
- **Do the signs make sense?** The signs should all be positive.
- **Are the magnitudes realistic?** The force is almost three times the weight of the stopper, and the acceleration is almost three times that of gravity, which is reasonable for such a light object.

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2- Find the centripetal acceleration to find the force .
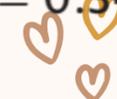
$a_c = \frac{4\pi^2 r}{T^2}$

$= \frac{4\pi^2 (0.93 \text{ m})}{(1.18 \text{ s})^2}$

$= 26$ m/s²

1- Find the data
m : 13 g
r : 0.93m
T : 1.18 s
F = ?N

3- Find the tensile strength .

$F_T = ma_c$

$= (0.013 \text{ kg})(26 \text{ m/s}^2)$

$= 0.34$ N

Example applications 3

الحل	القانون	المطلوب	المعطيات
$a_c = \dfrac{8^2}{25}$	$a_c = \dfrac{v^2}{r}$	ac	v = 8.8m/s
$a_c =$ 2.6			r=25m

12. A runner moving at a speed of 8.8 m/s rounds a bend with a radius of 25 m. What is the centripetal acceleration of the runner, and what agent exerts the centripetal force on the runner?

الحل	القانون	المطلوب	المعطيات
$5 = \dfrac{201^2}{r}$	$a_c = \dfrac{v^2}{r}$	r = ? km	v = 201m/s
r = 8080.2/1000 r = 8.0802 km			ac=5m/s^2

13. An airplane traveling at 201 m/s makes a turn. What is the smallest radius of the circular path (in kilometers) the pilot can make and keep the centripetal acceleration under 5.0 m/s^2?

Example applications 3

الحل	القانون	المطلوب	المعطيات
$a_c = \dfrac{4.1^2}{6.3}$	$a_c = \dfrac{v^2}{r}$	F	m = 45kg
$a_c = 2.7$	$F_{محصلة} = ma_c$		r = 6.3m
F = 45 x 2.7 Fc = 121.5			v = 4.1

14. A 45 kg merry-go-round worker stands on the ride's platform 6.3 m from the center, as shown in **Figure 11.** If her speed (v_{worker}) as she goes around the circle is 4.1 m/s, what is the force of friction (F_f) necessary to keep her from falling off the platform
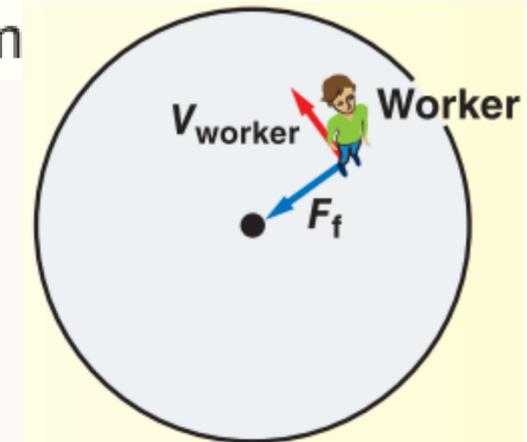

Figure 11

الحل	القانون	المطلوب	المعطيات
$a_c = \dfrac{4\pi^2 \times 1.4}{1.09^2}$	$a_c = \dfrac{4\pi^2 r}{T^2}$	Fc	m = 0.016 kg
$a_c = 46.5$	$F_{محصلة} = ma_c$		r = 1.4m
			T = 1.09s

15. A 16 g ball at the end of a 1.4 m string is swung in a horizontal circle. It revolves once every 1.09 s. What is the magnitude of the string's tension?

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Calculate the net torque when more than one torque acts on a body about a rotation axis .

1- Find the data

.τ: 35N.m
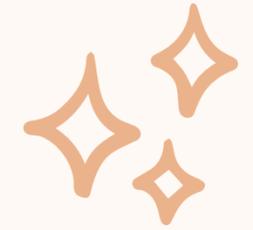
.r: 0.25m

.θ: 60.0

L = ?

F = ?

2- Find the length of the force arm (L)

$$L = r \sin \theta$$

$$= (0.25 \text{ m})(\sin 60.0°)$$

$$= 0.22 \text{ m}$$

3- Find the magnitude of the force (F)

$$\tau = Fr \sin \theta$$

$$35 = X \times 0.25 \times \sin(60)$$

shift solve ==

$$F = 1.6 \times 10^2 \text{ N}$$

EXAMPLE 1

LEVER ARM A bolt on a car engine must be tightened with a torque of 35 N·m. You use a 25 cm-long wrench and pull the end of the wrench at an angle of 60.0° to the handle of the wrench. How long is the lever arm, and how much force must you exert?

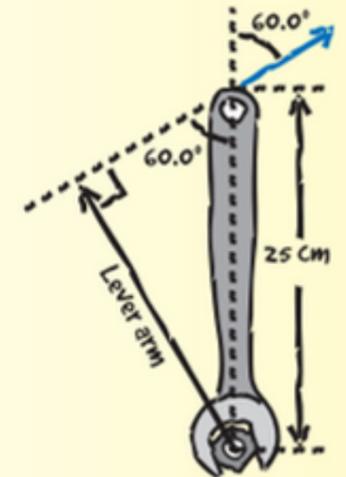**1 ANALYZE AND SKETCH THE PROBLEM**

Sketch the situation. Find the lever arm by extending the force vector backward until a line that is perpendicular to it intersects the axis of rotation.

KNOWN	UNKNOWN
$r = 0.25$ m $\tau = 35$ N·m	$L = ?$
$\theta = 60.0°$	$F = ?$

2 SOLVE FOR THE UNKNOWN

Solve for the length of the lever arm.

$L = r \sin \theta$

$= (0.25 \text{ m})(\sin 60.0°)$ ◄ Substitute $r = 0.25$ m and $\theta = 60.0°$ into the equation. Then, solve the equation.

$= 0.22$ m

Solve for the force.

$\tau = Fr \sin \theta$

$F = \dfrac{\tau}{(r \sin \theta)}$

$= \dfrac{(35 \text{ N·m})}{(0.25 \text{ m})(\sin 60.0°)}$ ◄ Substitute $\tau = 35$ N·m, $r = 0.25$ m, and $\theta = 60.0°$ into the equation.

$= 1.6 \times 10^2$ N ◄ Then, solve the equation. Remember to use significant digits.

3 EVALUATE THE ANSWER

• **Are the units correct?** Force is measured in newtons.

• **Does the sign make sense?** Only the magnitude of the force needed to rotate the wrench clockwise is calculated.

60.0°

60.0°

25 cm

Lever arm

Calculate the speed and orbital period of the satellite.

1- Find the data

h Height: 225 km .

me Earth's mass: 5.97 times 10^{24}.

re the radius of the Earth: 6.38 times 10^6.

v : ?

T : ?

2- Find the orbital radius

$r = re + h$

$r = 6.38 \times 10^6 + 225 \times 10^3$

$r = 6.60 \times 10^6$

4- Find the periodic time (T)   3- Find the orbital (v)

$$T = 2\pi\sqrt{\frac{r^3}{Gm_E}}$$

$$= 2\pi\sqrt{\frac{(6.60\times10^6 \text{ m})^3}{(6.67\times10^{-11} \text{ N·m}^2/\text{kg}^2)(5.97\times10^{24} \text{ kg})}}$$

$$= 5.34\times10^3 \text{ s}$$

يساوي تقريبًا 89 min أو 1.5 h.

$$v = \sqrt{\frac{Gm_E}{r}}$$

$$= \sqrt{\frac{(6.67\times10^{-11} \text{ N·m}^2/\text{kg}^2)(5.97\times10^{24} \text{ kg})}{6.60\times10^6 \text{ m}}}$$

$$= 7.77\times10^3 \text{ m/s}$$

ORBITAL SPEED AND PERIOD Assume that a satellite orbits Earth 225 km above its surface. Given that the mass of Earth is 5.97×10^{24} kg and the radius of Earth is 6.38×10^6 m, what are the satellite's orbital speed and period?

1 ANALYZE AND SKETCH THE PROBLEM

Sketch the situation showing the height of the satellite's orbit.

KNOWN	**UNKNOWN**
$h = 2.25\times10^5$ m	$v = ?$
$r_E = 6.38\times10^6$ m	$T = ?$
$m_E = 5.97\times10^{24}$ kg
$G = 6.67\times10^{-11}$ N·m^2/kg^2
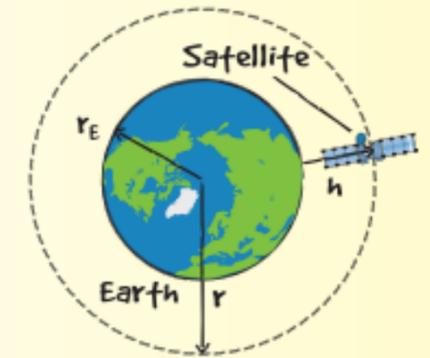
2 SOLVE FOR ORBITAL SPEED AND PERIOD

Determine the orbital radius by adding the height of the satellite's orbit to Earth's radius.

$r = h + r_E$

$= 2.25\times10^5$ m $+ 6.38\times10^6$ m $= 6.60\times10^6$ m   ◄ Substitute $h = 2.25\times10^5$ m and $r_E = 6.38\times10^6$ m.

Solve for the speed.

$v = \sqrt{\dfrac{Gm_E}{r}}$ ◄ Substitute $G = 6.67\times10^{-11}$ N·m^2/kg^2. $m_E = 5.97\times10^{24}$ kg, and $r = 6.60\times10^6$ m.

$= \sqrt{\dfrac{(6.67\times10^{-11} \text{ N·m}^2/\text{kg}^2)(5.97\times10^{24} \text{ kg})}{6.60\times10^6 \text{ m}}}$

$= 7.77\times10^3$ m/s

Solve for the period.

$T = 2\pi\sqrt{\dfrac{r^3}{Gm_E}}$ ◄ Substitute $r = 6.60\times10^6$ m, $G = 6.67\times10^{-11}$ N·m^2/kg^2. and $m_E = 5.97\times10^{24}$ kg.

$= 2\pi\sqrt{\dfrac{(6.60\times10^6 \text{ m})^3}{(6.67\times10^{-11} \text{ N·m}^2/\text{kg}^2)(5.97\times10^{24} \text{ kg})}}$

$= 5.34\times10^3$ s

This is approximately 89 min, or 1.5 h.

3 EVALUATE THE ANSWER

Are the units correct? The unit for speed is meters per second, and the unit for period is seconds.

السؤال 4 – صفحة 59 .

4. The truck in the previous problem is towing a trailer with wheels that have a diameter of 48 cm.

a. How does the linear acceleration of the trailer compare with that of the truck?

٤- إذا كانت الشاحنة التي في السؤال السابق تسحب قاطرة قطر كل من إطاراتها 48cm قارن بين :

a) التسارع الخطي للقاطرة والتسارع الخطي للشاحنة .

b) التسارع الزاوي للقاطرة والتسارع الزاوي للشاحنة .

a

التسارع الخطي للقاطرة = التسارع الخطي للشاحنة لا علاقة له بقطر الإطارات بل بالسرعة الخطية والزمن

b شاحنة

قاطرة

essafe brahim

$\alpha_1 = 5.23 rad/s^2$

$\alpha_2 = \dfrac{a}{r_2} = \dfrac{1.85 m/s^2}{0.24m} = 7.7 rad/s^2$

$r_2 = \dfrac{0.48m}{2} = 0.24m$

$r_1 = 0.708m$

$r_2 = 0.24m$

بما أن نصف قطر إطار القاطرة أقل من نصف قطر الشاحنة والتناسب بين نصف القطر والتسارع الزاوي عكسي إذا سوف يكون التسارع الزاوي للقاطرة أكبر منه للشاحنة .

Question 3 – Page 59.

3. If a truck has a linear acceleration of 1.85 m/s² and the wheels have an angular acceleration of 5.23 rad/s², what is the diameter of the truck's wheels?

a = 1.85 α = 5.23

d = ?

a = rα

1.85 = X x 5.23 – shift solve ==

r = 0.35

0.35 x 2 =

d = 0.7 m

Thank you !

Any questions ? Don't hesitate to ask for our help

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اللهم اعني في دراستي و بارك لي في وقتي و اجعل نهاية جهدي
فرحاً .. اللهم وفقني و يسر أمري .

لا تنسوني من دعواتكم