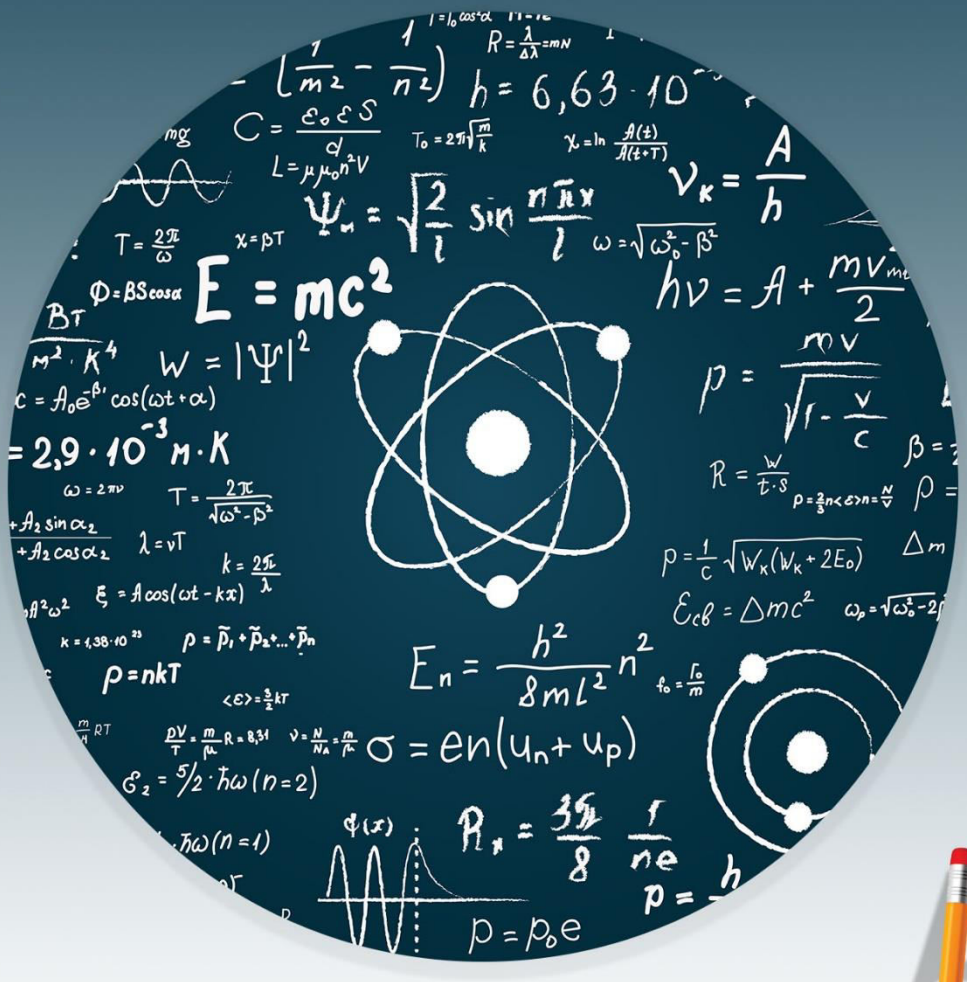
PHYSICS



WORKSHEET-13

STEP

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Worksheet-13

Topics:- Moment of Force, Equilibrium & Conditions

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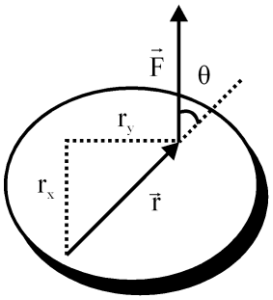
Q.1 The torque acting on a body will be half of maximum value when angle between force and position vector is:

A) 30° C) 60°

B) 45° D) 90°

Q.2 The torque in following figure is:



A) $r_x F\ \hat{n}$ C) $r\cos\theta F\ \hat{n}$

B) $r_y F\ \hat{n}$ D) Both "A" and "B"

Q.3 If the centre of gravity of a body does not shift when it is disturbed then the body is said to be in?

A) Stable equilibrium C) Neutral equilibrium

B) Unstable equilibrium D) Rotational equilibrium

Q.4 Which one is true statement:

A) A body in equilibrium implies that it is neither moving not rotating

B) If coplanar forces acting on a body form a closed polygon, then body is said to be in complete equilibrium

C) A body in equilibrium may move or rotate

D) Both "B" and "C"

Q.5 Torque is analogous to force for:

A) Translatory motion C) Rotational motion

B) Vibratory motion D) Linear motion

Q.6 The direction of torque in earth considering it to be an inertial frame of reference is:

A) Anti-clock wise C) Along axis of rotation

B) Clock wise D) Has no torque

Q.7 The torque produced by the weight of the body about the centre of gravity will be:

A) mgr C) $\vec{\omega}\times\vec{r}$

B) Zero D) $\vec{r}\times\vec{F}$

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Q.8 Work done by torque will be equal to:

A) Fd C) Iα

B) $r\theta$ D) $\tau\theta$

Q.9 As for translational motion we use relation F=ma similarly for angular motion this relation appears as:

A) $\tau = m\alpha$ C) $\tau = I\alpha$

B) $\tau = Ia$ D) $\tau = mr^2a$

Q.10 If the line of action of force passes through the axis of rotation, then the value of torque will be:

A) Maximum C) Negative

B) Zero D) Positive

Q.11 What is not true of the two forces that give rise to couple?

A) They act in opposite direction

B) They both act on the same body

C) They both act at the same point

D) They both have the same magnitude

Q.12 When a body is disturbed from it's equilibrium state such that it is said to be in stable equilibrium then?

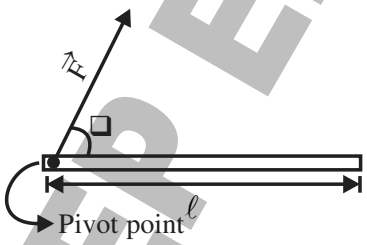
A) It returns to equilibrium position if released

B) It's P.E increases

C) It's line of action of weight remains within same base area

D) All of these

Q.13 For which value of "θ" in the figure shown torque becomes maximum?



A) 0° C) 180°

B) 90° D) No torque is produced

Q.14 A force $\vec{F}$ acts on a rod as shown in the figure. What is the relation for torque in it?

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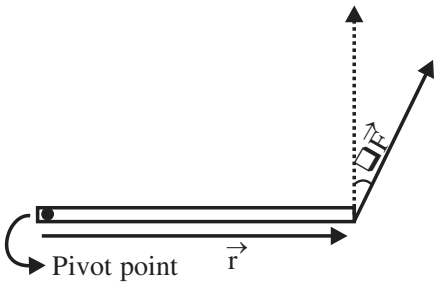


A) $\tau = rF\sin\theta$ C) $\tau = rF\tan\theta$

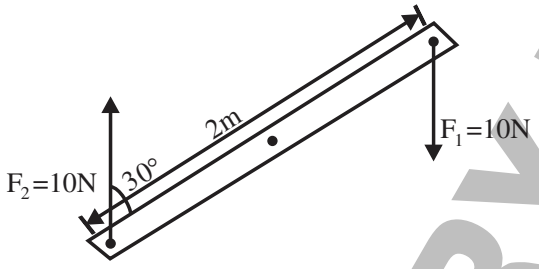
B) $\tau = rF\cos\theta$ D) $\tau = rF\cot\theta$

Q.15 In above Question for which value of "θ" torque becomes maximum?

A) θ=90° C) Both "A" and "B"

B) θ=270° D) θ=0°

Q.16 Consider the figure in which two forces act on a single rod of length 2 m as shown. What will be the value of moment of couple produced?



A) 20 N m C) 5 N m

B) 10 N m D) 30 N m

Q.17 The rate of change of angular momentum is equal to:

A) Linear momentum C) Torque

B) Force D) None of these

Q.18 The angular momentum of an object changes from 100 J s to 300 J s in 2 s. What will be the torque acting on it?

A) 100 N m C) 150 N m

B) 300 N m D) 0 N m

Q.19 Two objects having moment of inertia I_1:I_2=2:1. What will be the ratio of their respective rate of change of angular momenta (consider first object to be in equilibrium)?

A) 2:1 C) 0

B) 1:2 D) ∞

Q.20 An object is said to be in complete equilibrium if:

A) $\sum\vec{F}=0, \sum\vec{\tau}\neq 0$ C) $\sum\vec{F}=0, \sum\vec{\tau}=0$

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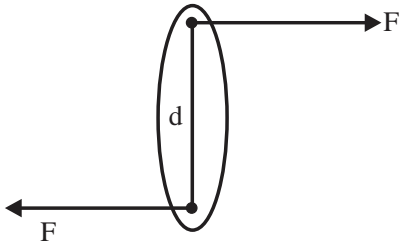
B) $\sum\vec{F}\neq 0, \sum\vec{\tau}=0$ D) $\sum\vec{F}\neq 0, \sum\vec{\tau}\neq 0$

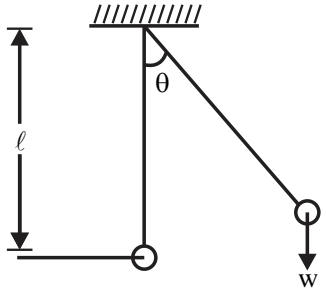
Q.21 What will be expression for moment of couple in the figure:



A) dF C) 2dF

B) dF/2 D) dF cosθ

Q.22 The expression of torque for following figure will be:



A) mg ℓ cosθ C) mg ℓ

B) mg ℓ sinθ D) mg ℓ tanθ

Q.23 The tyres of a car moving on road with constant velocity in a straight line are in _____ equilibrium.

A) Translational C) Dynamic

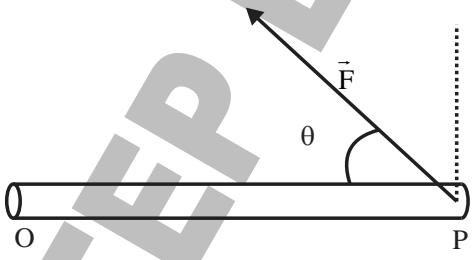
B) Rotational D) All of these

Q.24 The unit of "couple of forces" is same as that of:

A) Force C) Moment of couple

B) Torque D) Both B & C

Q.25 A force F is acting at point 'P' of uniform rod capable to rotate about "O" what is the torque about "O":



A) OPFsinθ C) OPFtanθ

B) OPFcosθ D) OPF

Q.26 A door requires a minimum torque of 100 N m in order to open it. What is the minimum distance of the handle from the hinge, if the door is to be pulled open with a

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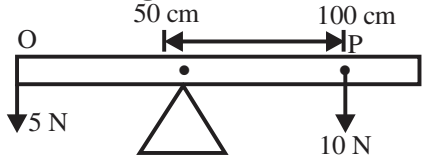
force at the handle not greater than 50 N.

A) 0.33 m C) 0.71 m

B) 2.0 m D) 1.54 m

Q.27 Two forces 5 N and 10 N are acting at 'O' and 'P' respectively on a uniform rod of length 100 cm suspended at the position of centre of gravity 50 cm mark as shown in figure.

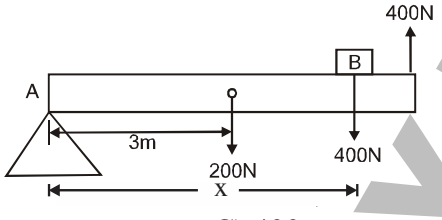


What is the position of P on meter rod?

A) 80 cm C) 75 cm

B) 70 cm D) 65 cm

Q.28 A uniform beam of 200 N is supported horizontally as show in fig. If the breaking tension of the rope is 400 N, how far can the block B of weight 400 N from point A on the beam as shown in fig.



A) 75 cm C) 400 cm

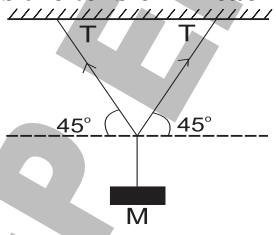
B) 300 cm D) 450 cm

Q.29 A uniform rod 30 cm long is pivoted at its centre. A 40-newton weight is hung 5 cm from the left end. Where must a 50-newton weight be hung to maintain equilibrium?

A) 5 cm from right end C) 6 cm from right end

B) 7 cm from right end D) 8 cm from right end

Q.30 A block of mass M shown in the figure below hangs motionless. What is the tension in each of the ropes?



A) Mg C) $\frac{Mg}{\sqrt{2}}$

B) $\frac{Mg}{2}$ D) $2Mg$

ANSWER KEY (Worksheet-13)					
1	A	11	C	21	A
2	B	12	D	22	B
3	C	13	D	23	D
4	C	14	B	24	A
5	C	15	D	25	A
6	D	16	B	26	B
7	B	17	C	27	C
8	D	18	A	28	D
9	C	19	C	29	B
10	B	20	C	30	C

SOLUTIONS

Unit – 2 (WS-13)

Q.1 Answer is "A"

Solution:- Magnitude of torque is given as:

$\tau = rF\sin\theta \rightarrow$ (i)

Given $\tau = \frac{\tau_{max}}{2} = \frac{rF}{2}$

Putting in (i)

$\frac{\cancel{rF}}{2} = \cancel{rF}\sin\theta$

$\frac{1}{2} = \sin\theta$

$\theta = 30°$

Q.2 Answer is "B"

Solution:- As $\vec{r}_x$ is parallel to $\vec{F}$, so torque due to this component is zero. All the torque produced will be due to $\vec{r}_y$.

Q.3 Answer is "C"

Solution:- If center of gravity of a body does not shift when it is disturbed then the body is said to be in neutral equilibrium.

Q.4 Answer is "C"

Solution:- By definition of equilibrium, a body is said to be in equilibrium if it is at rest or moving with constant velocity i.e its acceleration is zero, this means that a moving body or rotating body can be in equilibrium if its acceleration is zero.

Q.5 Answer is "C"

Solution:- Torque is the rotational analogous of force. It plays the same role in angular motion as the force plays in linear motion. Force produces linear acceleration & torque produces angular acceleration

Q.6 Answer is "D"

Solution:- $\tau = I\alpha$,

As $\omega = \text{constant}$ so $\alpha = 0, \tau = 0$

Q.7 Answer is "B"

Solution:- The weight of body is the force that passes through centre of gravity (which is the pivot point as well). So, the moment arm becomes zero, hence

$\tau = rF\sin\theta$

$r = 0$

$\tau = 0$

Q.8 Answer is "D"

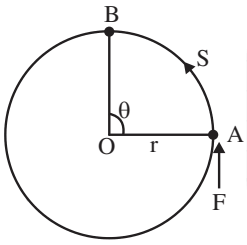
Solution:- Work done is given as:

$W = FS$

$W = F(r\theta)$

$W = (rF)\theta$

$W = \tau\theta$



$\tau = rF\sin\theta$

$\therefore$ between r and F in figure;

$\theta = 90°$

$\tau = rF$

Q.9 Answer is "C"

Solution:- 2nd law of motion for translational motion is;

$F = ma$

2nd law of motion for angular motion is;

$\tau = I\alpha$

Q.10 Answer is "B"

Solution:- When the line of action of force passes through pivot, moment arm becomes zero, so torque becomes zero.

Q.11 Answer is "C"

Solution:- Two forces acting on a body will give rise to couple if:

i. Both forces have same magnitude.

ii. Both forces have opposite direction.

iii. Both forces have different lines of action.

Q.12 Answer is "D"

Solution:- When a body in stable equilibrium is disturbed its P.E increases as it C.G point rises. Also the C.G point remains in the same base area.

Q.13 Answer is "D"

Solution:- As moment arm is zero so $\tau = 0$

Q.14 Answer is "B"

Solution:- Here angle between $\vec{F}$ and $\vec{r}$ is $90° - \theta$, which makes

$\tau = rF\sin(90° - \theta) = rF\cos\theta$

Q.15 Answer is "D"

Solution:- As the torque for given figure is;

$\tau = rF\cos\theta$

If $\theta = 0°$

$\tau = rF\cos 0°$

$\tau = rF = \max$

Q.16 Answer is "B"

Solution:-

τ_{couple} = (perpendicular distance between lines of action of forces) (magnitude of one force)

$\tau_{couple} = (r\sin\theta)(F_1)$

Q.17 Answer is "C"

Solution:- As $F = \frac{\Delta p}{\Delta t}$ so $\tau = \frac{\Delta L}{\Delta t}$

Q.18 Answer is "A"

Solution:- Torque in terms of angular momentum is given as;

$\tau = \frac{\Delta L}{\Delta t} = \frac{L_f - L_i}{\Delta t}$

$\tau = \frac{300 - 100}{2} = \frac{200}{2}$

$\tau = 100\,N\,m$

Q.19 Answer is "C"

Solution:- τ = rate of change of angular momentum $= I\alpha$

As First body is in equilibrium:

$\alpha_1 = 0$

$\tau_1 = 0$ so, $\frac{\tau_1}{\tau_2} = \frac{0}{\tau_2} = 0$

Q.20 Answer is "C"

Solution:- For complete equilibrium of a body, both conditions of equilibrium must be satisfied i.e

$\sum \vec{F} = \vec{0}$ and $\sum \vec{\tau} = \vec{0}$

Q.21 Answer is "A"

Solution:- Moment of couple = (perpendicular distance between lines of action of forces) (magnitude of one force)

Q.22 Answer is "B"

Solution:- Basic relation. Here moment $arm = \ell$, and $F = mg\ sin\theta$ so put in $r \times F$.

Q.23 Answer is "D"

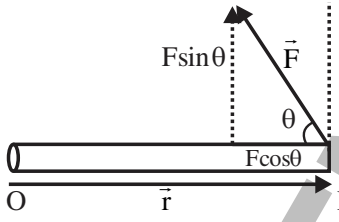
Solution:- The tyres of car spin about their axis with constant angular velocity and move in straight line with constant linear velocity, so both accelerations in body are zero and body is in translational, rotational and dynamic equilibrium.

Q.24 Answer is "A"

Solution:- Couple of forces has same units as that of force while moment of couple has the units same as that of torque.

Q.25 Answer is "A"

Solution:-



Torque is produced due to that component of force which is perpendicular to position vector $\vec{r}$. In the given figure Fsinθ is perpendicular to $\vec{r}$ or $\overrightarrow{OP}$, so

$\tau = \overline{OP}F\sin\theta$

Q.26 Answer is "B"

Solution:- Use relation; $\tau = rF$

Q.27 Answer is "C"

Solution:-

Step-I

Find distance "x" of "P" point from pivot by using

$\tau_{\text{clockwise}} = \tau_{\text{anticlockwise}}$

Step-II

Find distance of "P" from "O" by adding 50 cm in "x".

Q.28 Answer is "D"

Solution:-

Find distance x of "B" from pivot by using

$\tau_{\text{clockwise}} = \tau_{\text{anticlockwise}}$

Q.29 Answer is "B"

Solution:-

Find distance of 50 N weight from pivot by using

$\tau_{\text{clockwise}} = \tau_{\text{anticlockwise}}$

Then see what is the distance from right end.

Q.30 Answer is "C"

Solution:- Use relation; $2T_y = Mg$

STEP

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