## Chapter 09 <br> Circular Motion

## Multiple Choice Questions part (2)

22. Calgary, Canada is at a latitude of 51.0 degrees north. If one were to travel due south on the Earth's surface from Calgary, what distance would one have to cover to reach the equator. (The radius of the earth is 6370 km )
A. 3310 km
B. 4340 km

Moving on Earth's surface like moving on an ARC
C. 5490 km
D. 5670 km
E. $10,020 \mathrm{~km}$

$$
\begin{aligned}
\operatorname{arc}=\theta r= & \frac{51(2 \pi) \mathrm{rad}}{360} \times 6370 \\
& =5670 \mathrm{~km}
\end{aligned}
$$

Bauer - Chapter 09 \#16
Less difficult
Section: 09.02
23. Calgary, Canada is at a latitude of 51.0 degrees north. How fast is Calgary moving eastward as the Earth rotates? (The radius of the earth is 6370 km )
A. $0 \mathrm{~km} / \mathrm{h}$
B. $1050 \mathrm{~km} / \mathrm{h}$
C. $1300 \mathrm{~km} / \mathrm{h}$
D. $1520 \mathrm{~km} / \mathrm{h}$
E. $1670 \mathrm{~km} / \mathrm{h}$

$$
\frac{V \cdot \boldsymbol{\boldsymbol { s } ^ { \prime }} \frac{\text { خط الاستو }=\omega R=\frac{2 \pi \times 6370}{24}}{}=1667 \cdot 7 \mathrm{kmlh}}{\mathrm{~V}_{\text {(any angle to noth })}}=\begin{aligned}
& 1667.7 \cos (\theta) \\
& =1667.7 \cos (51) \\
& =1050 \mathrm{kmVh}
\end{aligned}
$$

Bauer - Chapter 09 \#17
More difficult
Section: 09.03
24. A point on Earth's surface in the northern hemisphere is moving eastward at 1300 $\mathrm{km} / \mathrm{h}$. What is the latitude of this point? (The radius of the earth is 6370 km )
A. $45^{\circ}$ north
B. $39^{\circ}$ north
C. $30^{\circ}$ north
D. $51^{\circ}$ north
E. $43^{\circ}$ north

Bauer - Chapter 09 \#17
More difficult
Section: 09.03
25. A racing motorcycle accelerates at a constant rate from zero to $280 \mathrm{~km} / \mathrm{h}$ in 39 seconds. If the outer diameter of the motorcycle's wheels is 64 cm and they turn without slipping, the angular acceleration of each wheel is
A. $5.73 \mathrm{rad} / \mathrm{s}^{2}$.
B. $11.5 \mathrm{rad} / \mathrm{s}^{2}$.
C. $3.12 \mathrm{rad} / \mathrm{s}^{2}$.
D. $22.4 \mathrm{rad} / \mathrm{s}^{2}$.

$$
\mathrm{V}_{\mathrm{f}}=280 \times 1000 \backslash 3600=77.77 \mathrm{mls}
$$

E. $6.23 \mathrm{rad} / \mathrm{s}^{2}$.

$$
\begin{gathered}
V_{F}=V_{i}+a t \\
77.77=0+a(39) \Rightarrow a=1 \cdot 994 \quad \mathrm{~m} \backslash \mathrm{~s} \\
\alpha=\frac{\mathbf{a}}{R}=\frac{1.994}{0 \cdot 32}=6.23 \quad \mathrm{rad} \backslash \mathrm{~s}^{2}
\end{gathered}
$$

26. A rock moves in uniform circular motion attached to a string. At point $X$ the string is cut with a very sharp blade and the rock is no longer attached to the string. In what direction will the rock travel?

A. in toward the center (a)
B. in a curved line, away from the circle (b)
C. in a straight line (c)
D. away from the center (d)
E. None are correct.

Bauer - Chapter 09 \#19
Less difficult
Section: 09.04
27. What speed can a driver travel on the Daytona Speedway (bank angle $31^{\circ}$ ) without using friction between his tires and the road to make the turn? The radius of the turn is 301 m .
A. $13 \mathrm{~m} / \mathrm{s}$
B. $39 \mathrm{~m} / \mathrm{s}$
C. $42 \mathrm{~m} / \mathrm{s}$
D. $50 \mathrm{~m} / \mathrm{s}$

Self learning 9.7

$$
v=\sqrt{g R \tan \theta}=
$$

Bauer - Chapter 09 \#20
More difficult
Section: 09.07
28. The maximum speed a driver travel on the Daytona Speedway (bank angle ${ }^{31^{\circ}}$ ) without using friction between his tires and the road to make the turn is $45 \mathrm{~m} / \mathrm{s}$. What is the radius of the turn?
A. 301 m
B. 401 m
C. 344 m
D. 241 m

## Self learning 9.7

$$
v=\sqrt{g R \tan \theta}=
$$

Bauer - Chapter 09 \#20
More difficult
Section: 09.07
29. The maximum speed a driver can travel on the banked curve on the Daytona Speedway is $45 \mathrm{~m} / \mathrm{s}$ without using friction between his tires and the road to make the turn. The radius of the turn is 301 m . What is the angle of the bank

Self learning 9.7

$$
v=\sqrt{g R \tan \theta}=
$$ relative to the horizontal?

A. $47^{\circ}$
B. $43^{\circ}$
C. $34^{\circ}$
D. $31^{\circ}$

Bauer - Chapter 09 \#20
More difficult
Section: 09.07
30. A ceiling fan is rotating in counter-clockwise direction (looking up from the ground) but it is slowing down. What direction are $\omega$ and $\alpha$ ?

|  |  |  |
| :--- | :--- | :--- |
| A. | down |  |
| B. | down |  |
| C. | up |  |
| D. |  | down |
| D. | up | up |
| E. | right | left |

A. Option A
B. Option B
C. Option C
D. Option D
E. Option E

32. A $1-\mathrm{m}$ long pendulum with a mass of 5 kg moves at a velocity of $3 \mathrm{~m} / \mathrm{s}$ at the bottom of its swing. What it the tension in the string at this point?
A. 45 N
B. 94 N
C. 49 N
D. 73 N
E. 67 N

$$
\begin{gathered}
F_{c}=T-m g \\
\Rightarrow T=\frac{m v^{2}}{R}+m g \\
T=\frac{5 \times 3^{2}}{1}+(5 x 9.81) \\
T=94 \mathrm{~N}
\end{gathered}
$$

33. A penny sits 20 cm from the axis on an old record, which is spinning at 45 rpm . The penny just starts to slip at this speed. What is the coefficient of friction between the penny and the record?
A. 0.23
B. 0.096
C. 0.41
D. 0.33
E. 0.18
F. 0.45

$$
\begin{gathered}
\mathrm{F}_{\mathrm{f}}=\mathrm{F}_{\mathrm{c}} \\
\mu m g=\frac{m v^{2}}{R}=\frac{m\left(\omega^{2} R^{2}\right)}{R} \\
\mu=\frac{\omega^{2} R}{9}=\frac{(1.5 \pi)^{2} \times 0.20}{9.81} \\
\mu=0.45
\end{gathered}
$$

34. You are riding as a passenger in a car, and you round a corner, and you are pushed against the car door. Which of the following are most accurate?
A. A force pushes you outward against the car door.
B. You are traveling in a straight line while the car turns about you.
C. The car door exerts a normal force on you.
D. You are exerting a fictional force on the car door.
E. None are correct.

Bauer - Chapter 09 \#26
Less difficult
Section: 09.05
35. A turntable is initially at rest. It starts rotating with a constant maximum angular acceleration for a period of 5 seconds. It then starts to slow down with an angular acceleration of $-1 \mathrm{rad} / \mathrm{s}^{2}$ for another 5 seconds. At the end of the 10 second period the turntable has undergone 20 rotations. What is the maximum angular acceleration the turntable reaches?
A. $-1 \mathrm{rad} / \mathrm{s}^{2}$
B. $2 \mathrm{rad} / \mathrm{s}^{2}$
C. $1 \mathrm{rad} / \mathrm{s}^{2}$
D. $-3.68 \mathrm{rad} / \mathrm{s}^{2}$
E. $3.68 \mathrm{rad} / \mathrm{s}^{2}$

$$
\begin{aligned}
\Delta \theta_{1} & +\Delta \theta_{2} \\
0.5(25) \alpha+(25 \alpha-12.5) & =20(2 \pi) \\
\alpha & =30 \pi \\
& =3.68 \mathrm{rad} \backslash \mathrm{~s}^{2}
\end{aligned}
$$

## Bauer - Chapter 09 \#27

More difficult
Section: 09.06
37. The angular acceleration versus time an object undergoing circular motion is shown in the figure below. If the object started from rest at $t=0 \mathrm{~s}$, the net angular displacement of the object at $t=t_{f}$ is $\alpha$ (radis ${ }^{2}$ )

A. in the clockwise direction.
B. in the counter-clockwise direction.
C. zero.
D. The displacement cannot be determined.
38. The angular acceleration versus time for an object undergoing circular motion is shown in the figure below. If the object started from rest at $t=0 \mathrm{~s}$, the net angular velocity of the object at $t=t_{f}$ is
$\alpha$ (radis ${ }^{2}$ )

A. in the clockwise direction.
B. in the counter clockwise direction.
C. zero.
D. The angular velocity cannot be determined.
39. The angular velocity versus time for an object undergoing circular motion is shown in the figure. If the obiect started from rest at $t=0 \mathrm{~s}$, the net angular displacement of the object at $t^{\omega}$ (rad's)

A. in the clockwise direction.
B. in the counter-clockwise direction.
C. zero.
D. The displacement cannot be determined.
40. A ball attached to a string moves in a horizontal circle of radius 1 m . It makes one revolution in 4 seconds. The magnitude of its acceleration is
A. $2.5 \mathrm{~m} / \mathrm{s}^{2}$.
B. $3.9 \mathrm{~m} / \mathrm{s}^{2}$.
C. $6.4 \mathrm{~m} / \mathrm{s}^{2}$.

$$
a_{c}=\omega^{2} R=\left(\frac{2 \pi}{T}\right)^{2} R=\left(\frac{2 \pi}{4}\right)^{2} \times 1=2.46 \mathrm{mls}{ }^{2}
$$

D. $9.8 \mathrm{~m} / \mathrm{s}^{2}$.
E. $12.4 \mathrm{~m} / \mathrm{s}^{2}$.
41. An old music record rotates with 33.3 revolutions per minute. Its angular speed is
A. $0.555 \mathrm{rad} / \mathrm{s}$.
B. $2.5 \mathrm{rad} / \mathrm{s}$.
C. $3.49 \mathrm{rad} / \mathrm{s}$.
D. $5.38 \mathrm{rad} / \mathrm{s}$.

$$
\omega=2 \pi \mathrm{f}=2 \pi(33.3 \backslash 60)=3.49 \mathrm{rad} \backslash \mathrm{~s}
$$

E. $9.8 \mathrm{rad} / \mathrm{s}$.

Bauer - Chapter 09 \#32
Less difficult
Section: 09.03
42. Suppose the people standing at rest with respect to the Earth on the Earth's equator are weightless. The radius of the earth is $6.37 \times 10^{6} \mathrm{~m}$. The length of the day under this condition would be
A. 21 hours.
B. 6 hours.
C. 2.1 hours.
D. 84.4 min .
E. 41.5 min .

$$
\begin{aligned}
& \text { Weightless means Normal Force }=\text { zero } \\
& \qquad \begin{array}{c}
v=\sqrt{9 R}=\sqrt{9.81 \times 3.37 \times 10^{6}}=7905 \quad \mathrm{~km} \backslash \mathrm{~h} \\
v=\omega R \Rightarrow 7905=\frac{2 \Pi R}{T} \\
T=\frac{2 \pi R}{7905}=5063 \mathrm{~s}=84.4 \mathrm{~min}
\end{array}
\end{aligned}
$$

43. A $45-\mathrm{kg}$ woman is riding a

Ferris wheel of radius 15 m at a constant speed. The speed of the Ferris wheel that would make her weightless at the top is
A. $12.1 \mathrm{~m} / \mathrm{s}$.
B. $9.8 \mathrm{~m} / \mathrm{s}$.
C. $7.5 \mathrm{~m} / \mathrm{s}$.
D. $3.2 \mathrm{~m} / \mathrm{s}$.
E. $1.9 \mathrm{~m} / \mathrm{s}$.

Weightless means Normal Force $=$ zero

$$
v=\sqrt{9 R}=\sqrt{9.81 \times 15}=12.1 \mathrm{~m} \backslash \mathrm{~s}
$$

45. The wheel of a racing car is rotating at 200 rpm at a given instant of time. In the next minute it makes 100 revolutions. The angular acceleration of the wheel is
A. $-4.9 \mathrm{rad} / \mathrm{s}^{2}$.
B. $-2.5 \mathrm{rad} / \mathrm{s}^{2}$.
C. $-1.5 \mathrm{rad} / \mathrm{s}^{2}$.
D. $-0.50 \mathrm{rad} / \mathrm{s}^{2}$.
E. $-0.35 \mathrm{rad} / \mathrm{s}^{2}$.

$$
\begin{gathered}
\Delta \theta=w_{0} t+\frac{1}{2} \alpha t^{2} \\
\Rightarrow 200 \Pi=\frac{20 \pi x 60}{3}+0.5 \alpha(60)^{2}
\end{gathered}
$$

$$
\begin{aligned}
& 200 \pi-400 \pi=1800 \alpha \\
& \alpha=-0.349 \mathrm{rad} \backslash \mathrm{~s} 2
\end{aligned}
$$

