

# UNIFORM CIRCULAR MOTION

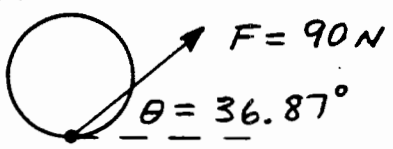
1. THE TACHOMETER IN BOBBY'S JEEP CHEROKEE READS 3300 RPM. FIND THE :

- A) NUMBER OF ROTATIONS WHICH THE ENGINE MAKES IN FIVE MINUTES. (16500 CYCLES)
- B) FREQUENCY IN HERTZ. (55 Hz)
- C) TIME TO MAKE ONE ROTATION. (.0182 sec)

2. BALBOA PARK! THE CAROUSEL, WHOSE RADIUS IS 7.64 m, ROTATES WITH A PERIOD OF EIGHT SECONDS. FIND THE :

- A) FREQUENCY IN HERTZ AND IN RPM. (.125 Hz, 7.5 rpm)
- B) NUMBER OF ROTATIONS IT CAN MAKE IN 136 SECONDS? ROTATIONS IN FOUR MINUTES? (17, 30 CYCLES)
- C) TIME REQUIRED TO MAKE FIFTY ROTATIONS. (400 sec)
- D) SPEED IF WE RIDE THE GIRAFFE ON THE OUTER EDGE OF THE CAROUSEL. (6 m/s)
- E) SPEED IF WE RIDE THE CAMEL, WHICH IS THREE-FOURTHS THE DISTANCE TO THE OUTER EDGE. (4.5 m/s)

3. A PARTICLE PERFORMING NON-UNIFORM CIRCULAR MOTION PICKS UP SPEED DURING ITS ORBIT, FIND THAT

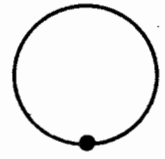


COMPONENT OF THE FORCE WHICH CAUSES THE PARTICLE TO :

- A) CHANGE ITS SPEED (72 N)
- B) CHANGE ITS DIRECTION (54 N)

4. A PARTICLE OF  $m = 3\text{ kg}$  ORBITS CLOCKWISE AT A CONSTANT SPEED OF  $20\text{ m/s}$  IN A CIRCLE OF RADIUS  $2.5\text{ m}$ .

A) SKETCH THE DIRECTION AND LABEL THE  $\vec{v}$ ,  $\vec{F}$  AND  $\vec{a}$  VECTORS.



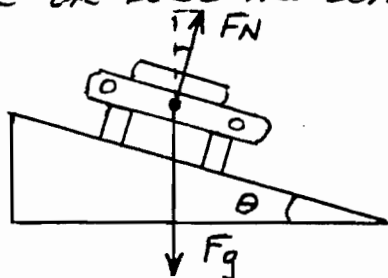
- B) FIND THE MAGNITUDE OF THE PARTICLE'S ACCELERATION, THE FORCE EXERTED ON IT, ITS FREQUENCY AND ITS PERIOD. ( $160\text{ m/s}^2$ ,  $480\text{ N}$ ,  $1.27\text{ Hz}$ ,  $.785\text{ sec}$ )
- C) IS THE PARTICLE ACCELERATING? WHY OR WHY NOT?

4<sup>1/2</sup>. A PARTICLE OF  $m = 3\text{ kg}$  ORBITS AT CONSTANT SPEED IN A CIRCLE OF  $r = 7\text{ m}$ . ITS PERIOD IS  $T = .4189\text{ SECONDS}$ . FIND  $v$ ,  $a$  AND  $F$ . ( $105$ ,  $1575$ ,  $4725$ )

5. A PARTICLE OF  $m = 3 \text{ kg}$  ORBITS IN A CIRCLE AT A FREQUENCY OF  $1.985 \text{ Hz}$  AS A RESULT OF A  $8400 \text{ N}$  CENTRIPETAL TENSION FORCE. FIND THE RADIUS. ( $18 \text{ m}$ )
6. AMY,  $m = 55 \text{ kg}$ , FLIES HER T.P.H.S. F-16 FALCON IN A VERTICAL LOOP AT  $240 \text{ m/s}$ . AT THE APEX OF THE LOOP, SHE IS UPSIDE DOWN AND FEELS AS IF SHE WEIGHS FIVE TIMES HER USUAL WEIGHT. FIND: A)  $F_g$  B)  $F_n$  C) THE RADIUS. ( $550, 2750, 960$ )
7. MAGIC MOUNTAIN! ELEANOR RIDES A ROLLER COASTER WHICH MAKES A VERTICAL LOOP OF RADIUS  $78.4 \text{ m}$ . AT THE VERTEX OF THE LOOP, SHE IS UPSIDE DOWN AND, JUST COMING OUT OF HER SEAT, SHE FEELS WEIGHTLESS. FIND HER SPEED. ( $28 \text{ m/s}$ )
8. STEPHANIE,  $m = 48 \text{ kg}$ , RIDES A FERRIS WHEEL WHOSE RADIUS IS  $392 \text{ m}$ . AT THE ZENITH OF THE LOOP, SHE IS RIGHT SIDE UP. THE SCALE UPON WHICH SHE SITS READS  $474 \text{ N}$ . FIND HER SPEED AND THE PERIOD OF HER MOTION. ( $7 \text{ m/s}$   $352 \text{ sec}$ )
9. CYCLOTRONS! THE WALL OF THE CYLINDER, WHOSE RADIUS IS  $9 \text{ m}$ , PRESSES SECURELY ON MIKE AS THEY ROTATE AT  $15 \text{ m/s}$ . FIND THE COEFFICIENT OF FRICTION FOR THE WALL SO THAT MIKE DOES NOT SLIP DOWNWARD. ( $.4$ )
10. AN UNBANKED MOUNTAIN ROAD, WHOSE COEFFICIENT OF FRICTION IS  $.25$ , MAKES A HAIRPIN TURN AS IT CLIMBS INDEPENDENCE PASS. FIND ITS RADIUS OF CURVATURE SO THAT WE MAY NEGOTIATE THE CURVE AT  $30 \text{ m/s}$ . ( $360$ )
11. WINTER OLYMPICS, NAGANO, JAPAN 1998! IN HER FLAME RED BOBSLED, NAO ZOOMS AROUND A VERTICALLY BANKED CURVE WHOSE RADIUS IS  $72.9 \text{ m}$ . SHE EXPERIENCES A CENTRIPETAL ACCELERATION OF  $4 g$ 's. FIND:
- A) HER ACCELERATION IN  $\text{m/s}^2$ . ( $40 \text{ m/s}^2$ )
- B) HER SPEED. ( $54 \text{ m/s}$ )
- C) THE COEFFICIENT OF FRICTION SO THAT SHE SAFELY NEGOTIATES THE CURVE. ( $.25$ )

12. BOND, IN HIS METALLIC GREEN 911 PORSCHE, ZOOMS AT  $40 \text{ m/s}$  AROUND AN UNBANKED ALPINE CURVE AS HE DESCENDS THE BRENNER PASS. THE CURVE HAS RADIUS OF  $490 \text{ m}$  AND COEFFICIENT OF FRICTION  $.36$ . IS BOND SAFE OR DOES HE SOAR LIKE AN AUSTRIAN EAGLE? (<sup>SAFE</sup> BY  $2 \text{ m/s}$ )

13.



MONTE CARLO! FORMULA-1 RACE CARS ZOOM AT  $45 \text{ m/s}$  AROUND A FRICTIONLESS CURVE WHOSE RADIUS IS  $270 \text{ m}$ .

A) FIND THE ANGLE OF THE

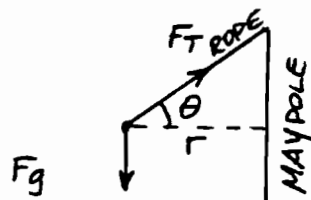
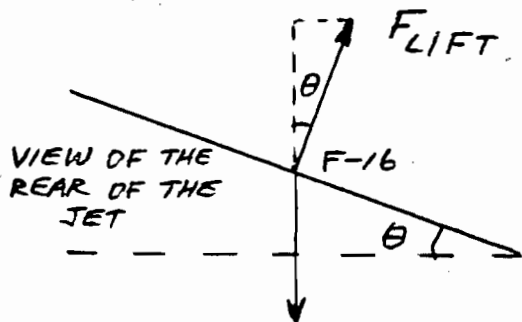
BANK SO THAT THE CARS SAFELY TRAVERSE THE CURVE. ( $36.87^\circ$ )

B) FOR A CAR WHOSE MASS IS  $1800 \text{ kg}$ , FIND  $F_N$ . ( $22500 \text{ N}$ )

14. CHRISTINA FLIES HER T.P.H.S. F-16 FALCON IN A HORIZONTAL CIRCLE WHOSE RADIUS IS  $4707 \text{ m}$ . THE JET, WHOSE MASS IS  $3600 \text{ kg}$ , IS TILTED AT  $22.62^\circ$ .

A) FIND  $F_{\text{LIFT}}$ . ( $39000 \text{ N}$ )

B) FIND THE SPEED. ( $140 \text{ m/s}$ )



15. NIKOLAY,  $m = 66 \text{ kg}$ , ORBITS AT  $14 \text{ m/s}$  ON THE END OF A ROPE AROUND A MAYPOLE. THE RADIUS OF HIS ORBIT IS  $11.55 \text{ m}$ . FIND  $\theta$ , THE LENGTH OF THE ROPE AND THE TENSION IN THE ROPE. ( $30.51^\circ$ ,  $13.41 \text{ m}$ ,  $1300 \text{ N}$ )

16. TYLER,  $m = 90 \text{ kg}$ , HANGS ON THE END OF A ROPE AS HE ORBITS A MAYPOLE AT  $\theta = 58.11^\circ$ . HE TAKES  $6.9$  SECONDS TO MAKE ONE REVOLUTION. FIND:

A) THE TENSION IN THE ROPE. ( $1060 \text{ N}$ )

B) THE RADIUS OF HIS ORBIT ( $7.5 \text{ m}$ )

C) THE SPEED ( $6.83 \text{ m/s}$ )

D) THE LENGTH OF THE ROPE ( $14.2 \text{ m}$ )

## REFERENCE FRAMES

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1. VALERIE IS RIDING THE GRAVITRON AT MAGIC MOUNTAIN. DRAW FORCE DIAGRAM FOR THE INERTIAL AND FOR THE NON-INERTIAL REFERENCE FRAMES. USE DOTTED LINES FOR PSEUDO FORCES. GIVE A BRIEF EXPLANATION OF NEWTON'S 2<sup>ND</sup> LAW FROM EACH POINT OF VIEW.
2. A HURRICANE STRIKES THE FIJI ISLANDS IN THE SOUTH PACIFIC. AS IN PROBLEM ONE, DRAW THE TWO FORCE DIAGRAM WITH EXPLANATIONS.
3. CHAN FLIES TO VENUS AND SETS UP A FOUCAULT PENDULUM ON THE SOUTH POLE. CHAN HOLDS THE MASS ON HER NOSE AND LETS IT GO. AS IT SWINGS AWAY FROM HER, CHAN SEES THE BOB VEER OFF TO HER RIGHT. 121.5 DAYS LATER, THE MASS SWINGS BACK TO AGAIN TOUCH HER NOSE.
  - A) LOOKING DOWN ON THE SOUTH POLE OF VENUS, WHICH DIRECTION, CLOCKWISE OR COUNTERCLOCKWISE, DOES THE PLANET SPIN ON ITS AXIS?
  - B) LOOKING DOWN ON THE NORTH POLE, WHICH WAY DOES VENUS SPIN?
  - C) HOW MANY DAYS DOES IT TAKE VENUS TO MAKE ONE ROTATION ON ITS AXIS?
4. A FOUCAULT PENDULUM ON EARTH VEERS RIGHT IN THE NORTHERN HEMISPHERE. ITS PLANE OF SWING WILL MARCH AROUND A COMPLETE CIRCLE IN A TIME,  $T$ , GIVEN BY:

$$T = (24 \text{ HRS}) / (\sin \theta)$$

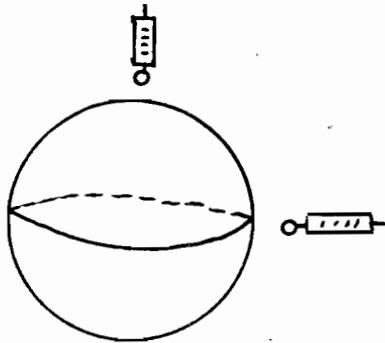
WHERE  $\theta$  = THE LATITUDE

DEL MAR IS AT LATITUDE  $33^\circ \text{N}$ . FIND THE TIME FOR A TORREY PINES HIGH SCHOOL FALCON FOUCAULT PENDULUM TO MARCH AROUND A COMPLETE CIRCLE. (44.1 HRS)

5. A 2 KG MASS IS HUNG FROM A SPRING SCALE.

$F_g = mg$  IS THE TRUE WEIGHT

$F_T$  = THE APPARENT WEIGHT



EARTH'S RADIUS =  
 $6.378 \times 10^6 \text{ m}$

A) FIND  $F_g$  AT BOTH THE NORTH POLE AND THE EQUATOR. (20N)

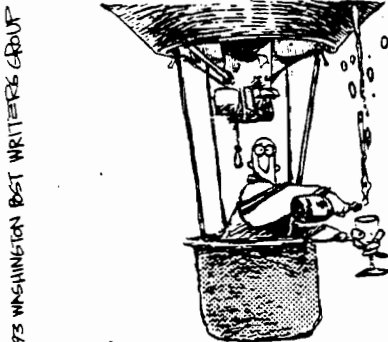
B) FIND THE APPARENT WEIGHT AT THE NORTH POLE. (20N)

C) FIND THE TANGENTIAL SPEED AT THE EQUATOR DUE TO THE SPIN OF THE EARTH.

(464 m/s = 1040 MPH!)

d) FIND THE APPARENT WEIGHT OF THE MASS AT THE EQUATOR. (19.93 N)

NON SEQUITUR by WILEY MILLER



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