**Problem:** A 5 kg object is in uniform circular motion traveling a circular path of radius 1.2 m with a speed of 23 m/s. (a) What is the object's centripetal acceleration? (b) What centripetal force is necessary to keep the object in this circular path?

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| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
| **(C) Math Representation and Solution**<br><br>Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?<br><br>After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer. | |
| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

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| **Problem:** | A 3 kg object is being rotated by a string in vertical circular motion of radius 1.6 m. (a) If a constant speed of 5 m/s is maintained for the entire circle, what centripetal force is necessary? (b) What speed is necessary for the object barely to pass the top of the circle but still be in circular motion (i.e, critical speed)? |
| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
| **(C) Math Representation and Solution**<br><br>Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?<br><br>After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer. | |
| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

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| **Problem:** | A 150 g ball at the end of a string is revolving uniformly in a horizontal circle of radius 0.600 m. The ball makes 2.00 revolutions in a second. What is its centripetal acceleration? |
| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
| **(C) Math Representation and Solution**<br><br>Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?<br><br>After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer. | |
| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

**Problem:** A horizontal force of 210 N is exerted on a 2.0 kg discus as it rotates uniformly in a horizontal circle (at arm's length) of radius 0.90 m. Calculate the speed of the discus.

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| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
| **(C) Math Representation and Solution**<br><br>Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?<br><br>After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer. | |
| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

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| **Problem:** | A small coin is placed on a flat, horizontal turntable. The turntable is observed to make three revolutions in 3.14 s. (a) What is the speed of the coin when it rides without slipping at a distance 5.0 cm from the center of the turntable? (b) What is the acceleration (magnitude and direction) of the coin? (c) What is the magnitude of the frictional force acting on the coin if the coin has a mas of 2.0 g? (d) What is the coefficient of static friction between the coin and the turntable if the coin is observed to slide off the turntable when it is more than 10 cm from the center of the turntable? |
| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
| **(C) Math Representation and Solution**<br><br>Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?<br><br>After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer. | |
| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

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| **Problem:** | On an ice rink, two skaters of equal mass grab hands and spin in a mutual circle once every 2.5 s. If we assume their arms are each 0.80 m long and their individual masses are 60.0 kg, how hard are they pulling on one another? |

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| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
| **(C) Math Representation and Solution**<br><br>Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?<br><br>After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer. | |
| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

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| **Problem:** | A space station in a science fiction novel consists of a circular tube that will rotate about its center (like a bicycle wheel) of about 1.1 km. What must be the rotation speed (revolutions per day) if an effect equal to gravity at the surface of the Earth (1.0g) is to be felt? |
| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
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| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

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| **Problem:** | A jet pilot takes his airplane in a vertical loop. (a) If the jet is moving at a speed of 1300 km/h at the lowest point of the loop, determine the minimum radius of the circle so that the centripetal acceleration at the lowest point does not exceed 6.0 g's. (b) Calculate the 78 kg pilot's effective weight at the bottom of the circle, and (c) at top of the circle (assume the same speed). |
| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
| **(C) Math Representation and Solution**<br><br>Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?<br><br>After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer. | |
| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

**Problem:** A carnival Ferris wheel has a 15 m radius and completes five turns about its horizontal axis every minute. (a) What is the acceleration of a passenger at the highest point? (b) What is the acceleration at the lowest point?

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| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
| **(C) Math Representation and Solution**<br><br>Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?<br><br>After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer. | |
| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

**Problem:** How many revolutions per minute would a 15 m diameter Ferris wheel need to make for the passengers to feel "weightless" at the topmost point?

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| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
| **(C) Math Representation and Solution**<br><br>Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?<br><br>After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer. | |
| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

**Problem:** If the coefficient of static friction for tires on a road is 0.25, at what maximum speed can a car round a level curve of 47.5 m radius without slipping?

**(A) Pictorial Representation**

Include:
- a coordinate axis,
- a sketch of the situation described in the problem.
- symbols that represent the known values, and
- a symbol representing the unknown(s) that you wish to determine.

**(B) Physical Representation**

Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest).

**(C) Math Representation and Solution**

Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?

After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer.

**(D) Evaluation**
- Does the sign of the answer agree?
- Is the unit of the answer correct?
- Is the magnitude reasonable?

 

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| **Problem:** | How large must the coefficient of static friction be between the tires and the road if a car is to round a level curve of radius 85 m at a speed of 95 km/h? |
| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
| **(C) Math Representation and Solution**<br><br>Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?<br><br>After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer. | |
| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

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| **Problem:** | Kerry is driving her new car (of mass 1200 kg) when she encounters a small "bump" in the road. If Kerry maintains a constant speed of 20 m/s over the bump, what is her car's apparent weight at the top of the bump if the bump has a radius of 50 m? (b) If Kerry later goes through a dip in the road whose radius is 32 m, what is her car's apparent weight at the bottom of the bump? |
| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
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| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

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| **Problem:** | Marvin is driving his new Miata (mass 1200 kg) when he encounters a small "bump" in the road. If Marvelous Marv maintains a constant speed of 25 m/s over the bump, what is his car's apparent weight at the top of the bump if the bump has a radius of 65 m? (b) If Marv later goes through a dip in the road whose radius is 35 m, what is his car's apparent weight at the bottom of the bump with a car speed of 25 m/s? |
| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
| **(C) Math Representation and Solution**<br><br>Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?<br><br>After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer. | |
| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

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| **Problem:** | A 680 N student on a steadily rotating Ferris wheel has an apparent weight of 575 N at the highest point. (a) What is the student's apparent weight at the lowest point? (b) What is the student's apparent weight at the highest point if the wheel's speed is doubled? |
| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
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| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

**Problem:** At what minimum speed must a roller coaster be traveling when upside down at the top of the circle so that the passengers will not fall out? Assume a radius of curvature of 7.4 m?

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| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
| **(C) Math Representation and Solution**<br><br>Do you use kinematics first _________ to find the acceleration, or do you start with forces and Newton's second law _________?<br><br>After you decide, apply in whatever order you choose, Newton's second law in component form and kinematics to determine the answer. | |
| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

**Problem:** At an amusement park loop-the-loop ride, the loop has a radius of 10 m. In one of the cars, you are riding sitting on a scale which measures your apparent weight. Before the rides start, your apparent weight is 800 N. (a) What is your apparent weight at the top of the loop when the car is going 12 m/s? (b) What is your apparent weight at the bottom of the loop when the car is going 18 m/s?

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| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
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| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 

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| **Problem:** | Tarzan (m = 85.0 kg) tries to cross a river by swinging from a vine. The vine is 10.0 m long, and his speed at the bottom of the swing (as he just clears the water) is 8.00 m/s. Tarzan doesn't know that the vine has a breaking strength of 1000N. Does he make it safely across the river? |
| **(A) Pictorial Representation**<br><br>Include:<br>• a coordinate axis,<br>• a sketch of the situation described in the problem.<br>• symbols that represent the known values, and<br>• a symbol representing the unknown(s) that you wish to determine. | |
| **(B) Physical Representation**<br><br>Encircle the system (a vary important choice) in the above sketch. Then, construct a motion diagram and a force diagram for the system (and for each individual object of interest). | |
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| **(D) Evaluation**<br>• Does the sign of the answer agree?<br>• Is the unit of the answer correct?<br>• Is the magnitude reasonable? | |

 