AP Physics Pre-Exam – Unit 2 – Circular motion and Gravitation - KEY

Directions: Each of the questions or incomplete statements below is followed by four suggest answers or completions. Select the one that is best in each case and then enter the appropriate letter in the corresponding space on the answer sheet.

Note: To simplify calculations, you may use g = 10 m/s^2 in all problems

1. Two sacks contain the same number of identical apples and are separated by a distance r. The two sacks exert a gravitation force on each other that is opposite in direction but with the same magnitude, F. Half the apples are removed from one sack and placed in the second sack. What is the magnitude of the gravitational force between the two sacks in terms of the original force, F?

A) $\frac{1}{2}$F

B) $\frac{3}{4}$F

C) F

D) $\frac{3}{2}$F

$F_{old} = G\frac{m_1 m_2}{r^2}$ $F_{new} = G\frac{(\frac{3}{2}m)(\frac{1}{2}m)}{r^2}$

$F_{new} = \frac{3}{4} G\frac{(m_1)(m_2)}{r^2}$

$F_{old} = \frac{3}{4} F_{new}$

2. The radius of an asteroid's orbit about the Sun is approximately two times the radius of Earth's orbit about the Sun. Measured in Earth years, the time for the asteroid to make one complete revolution about the Sun is most nearly

A) 1.4 years

B) 2.0 years

C) 2.8 years

D) 8.0 years

Kepler's 3rd Law $\left(\frac{T_1}{T_2}\right)^2 = \left(\frac{R_1}{R_2}\right)^3$

Given:
$R_2 = 2R_1$
$T_1 = 1$ year
$T_2 = ?$ years

$T_2^2 = T_1^2\left(\frac{R_2}{R_1}\right)^3$

$T_2^2 = (1)^2\left(\frac{2}{1}\right)^3$

$T_2 = \sqrt{8}$

$T_2 = 2.8$ years

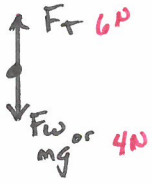
3. An object weighing 4 N swings back and forth on the end of a string. At the bottom of the swing, the tension in the string is 6 N. What is the magnitude of the centripetal acceleration of the object at the bottom of the swing?

A) 0

B) $\frac{1}{2}$g

C) g

D) $\frac{3}{2}$g



$F_c = F_{net}$

$ma_c = F_T - F_w$

$a_c = \frac{F_T - F_w}{.4}$

$= \frac{6-4}{.4}$

$a_c = 5\ m/s^2$

$\frac{5}{10} = \frac{1}{2}g$

$F_w = mg$

$\frac{4N}{g} = m$

$.4\ kg = m$

4. Most commercial satellites operate in geostationary orbits. A *geostationary orbit* is an orbit whose position in the sky remains the same for a stationary observer on Earth. However, some satellites operate at medium Earth orbits or low Earth orbits, and have periods that are less than 24 hours

Four satellites are in a circular orbit around Earth, well outside the atmosphere. The mass (m) and orbital radius (r) of each satellite are given in the provided data table. Which satellite has the greatest speed?

Satellite	Mass	Radius
A	$m/2$	r
B	m	$r/2$
C	m	r
D	m	$2r$

A) A

B) B

C) C

D) D

$F_{net} = F_c$

$G\frac{M m}{r^2} = m\frac{v_T^2}{r}$

$v_T^2 = GM\frac{1}{r}$

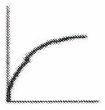
m of SAT doesn't matter

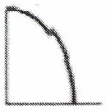
if r $v_T^2 = \frac{1}{r}$

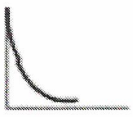
if $r/2$ $v_T^2 = 2$

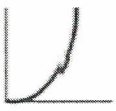
if $2r$ $v_T = \frac{1}{2r}$

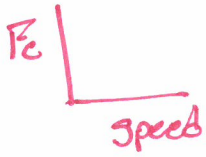
5. A 30-kg child sits on the edge of a merry-go-round. The child is located 6 m from the center of the merry-go-round. The tangential speed of the child is 12 m/s. The child moves from the edge to the center of the merry-go-round. Which of the graphs below best represents the centripetal force on the vertical axis versus the speed of the child on the horizontal axis?

A) 

B) 

C) 

D) 



$F_c = \frac{m v_T^2}{r}$

Spin faster @ Center

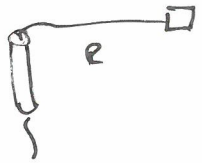
6. A student wishes to calculate the acceleration of a stopper tied to a end of a string. She whirls the stopper at a constant speed in a horizontal circular path of radius *R*. The stopper completes ten complete revolutions in a time interval Δt. The student calculates the time period, *T*, for one complete revolution. What additional information is needed to calculate the centripetal acceleration of the stopper?

A) No additional information

B) The mass of the stopper

C) The tension in the string

D) The frequency of the stopper



$a = \frac{v_T^2}{r}$ $v = 2\pi r$

7. A person weighing 800N on Earth travels to another planet that has twice the mass and twice the radius of Earth. The person's weight on this other planet is most nearly.

A) 400 N

B) $\frac{800}{\sqrt{2}}$ N

C) 800 N

D) $800\sqrt{2}$ N

$F_{new} = \frac{G(2m)m}{(2r)^2}$

$= \frac{2GMm}{4r^2}$

$F_{old} = \frac{GMm}{r^2}$

$F_{new} = \frac{1}{2} F_{old}$

$= \frac{1}{2}(800)$

$= 400$

8. A car initially travels north at a constant speed. As the car starts to make a left turn without changing speed, along a circular curve, a package on the seat of the car begins to slide toward the right side of the car. Which of the following is true of the net force on the package while it is sliding?

A) The force is directed to the right, away from the center of the circle

No F_c Always toward Center

B) The force is directed north

C) There is not enough force directed north to keep the package from sliding

D) There is not enough force directed to the left, toward the center of the circle, to keep the package from sliding

9. The planet Mars is host to five functioning spacecraft, three in orbit about the planet and two on the surface of the planet. Thanks to those spacecraft, we know that the planet Mars has a mass that is 0.11 times that of Earth and a radius that is 0.53 times that of Earth. The acceleration of an object in free-fall near the surface of Mars is most nearly what in terms of the local value of *g* on Earth?

$$F_{mars} = \frac{G(0.11M)m}{(0.53r)^2}$$

$$= 0.39\,\frac{GMm}{r^2}$$

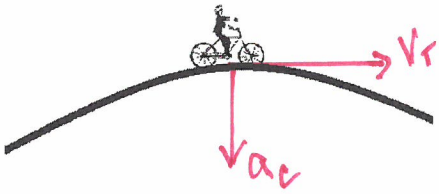
A) Zero

B) 0.10 g

C) 0.19 g

D) 0.39 g

10. A bicycle moves at constant speed over a hill along a smoothly curved surface as shown above. Which of the following best describes the directions of the velocity and the acceleration at the instant it is at the highest position?



A) The velocity is toward the right of the page and the acceleration is towards the top of the page.

B) The velocity is towards the right of the page and the acceleration is towards the bottom of the page

C) The velocity is towards the right of the page and the acceleration is towards the top of the page

D) The velocity is towards the top right of the page and the acceleration is towards the bottom right of the page

Directions: For each of the questions or incomplete statements below, two of the suggested answers will be correct. For each of these questions, you must select both correct choices to earn credit. No partial credit will be earned if only one correct choice is selected. Select the two that are best in each case and then enter both of the appropriate letters in the corresponding space on the answer sheet.

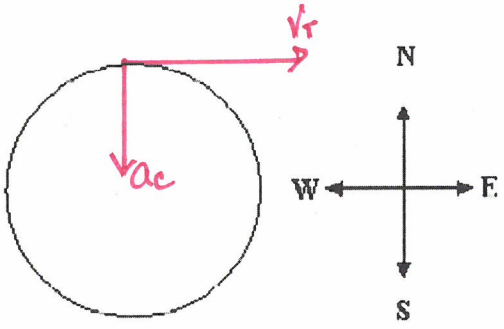
11. A racing car is moving around the circular track of radius 300 m as shown in the diagram. At the instant when the car's velocity is directed due east, its acceleration is directed due south and has a magnitude of 3 m/s^2. When viewed from above, during one complete lap around the track the car is moving (select two answers.)

A) Clockwise

B) Counterclockwise

C) With a changing speed

D) With a constant speed



12. A carnival merry-go-round rotates around a vertical axis at a constant rate. Two horses are attached to the rotating merry-go-round with the red horse placed at a shorter distance from the center of the merry-go-round than the blue horse. Which of the following statements are true concerning both horses? (Select two answers)

A) The blue horse has greater period than the red horse

B) The blue horse and the red horse have equal periods

C) The blue horse has a greater speed than the red horse

D) The blue horse and the red horse have equal speeds

- Rotate around same