Applications of Newton’s Laws: Exercise 2

1. A roller coaster car does a loop-the-loop. When it is upside down at the very top, which of the following is true?
   (a) The normal force and the weight are in opposite directions.
   (b) The normal force and the weight are perpendicular to each other.
   (c) The weight is zero.
   (d) The normal force and the weight are in the same direction.
   (e) None of the above.

2. A roller coaster car does a loop-the-loop. When it is right-side up at the very bottom, which of the following is true?
   (a) The normal force and the weight are in opposite directions.
   (b) The normal force and the weight are perpendicular to each other.
   (c) The weight is zero.
   (d) The normal force and the weight are in the same direction.
   (e) None of the above.

3. A roller coaster car is on a track that forms a circular loop in the vertical plane. If the car is barely to maintain contact with the track at the top of the loop, what is the minimum value for its centripetal acceleration at this point?
   (a) $|\vec{g}|$ downward.
   (b) $|\vec{g}|$ upward.
   (c) 0.5 $|\vec{g}|$ downward.
   (d) 2 $|\vec{g}|$ upward.
   (e) None of the above.

4. A stone is whirled in a vertical circle on a cord. Halfway up
   (a) the tension is towards the center of the circle and the net force is down.
   (b) the weight is down and the net force is towards the center of the circle.
   (c) the tension force is towards the center of the circle and the weight is down.
   (d) the weight and tension are in the same direction.
   (e) none of the above.
5. A stone, with mass number $m$, is attached to a strong string and whirled in a *vertical* circle of radius $|\vec{\rho}|$. At the exact *top* of the path the tension in the string is 3 times the stone’s weight. The magnitude of the stone’s instantaneous translational (tangential) velocity at this point is given by

(a) $2\sqrt{|\vec{g}||\vec{\rho}|}$.
(b) $\sqrt{2} |\vec{g}||\vec{\rho}|$.
(c) $2 |\vec{g}||\vec{\rho}|$.
(d) $4 |\vec{g}||\vec{\rho}|$.
(e) none of the above.

6. A stone, with mass number $m$, is attached to a strong string and whirled in a *vertical* circle of radius $|\vec{\rho}|$. At the exact *bottom* of the path the tension in the string is 3 times the stone’s weight. The magnitude of the stone’s instantaneous translational (tangential) velocity at this point is given by

(a) $2\sqrt{|\vec{g}||\vec{\rho}|}$.
(b) $\sqrt{2} |\vec{g}||\vec{\rho}|$.
(c) $2 |\vec{g}||\vec{\rho}|$.
(d) $4 |\vec{g}||\vec{\rho}|$.
(e) none of the above.

Problems 15 - 16 refer to the figure below.

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![Stress Strain Diagram](image)

7. Region A in the above figure is called the

(a) compressibility region.
(b) plastic region.
(c) elastic region.
(d) fraction region.
(e) none of the above.

8. The point C in the figure is called the
   (a) breaking point.
   (b) plastic limit.
   (c) elastic limit.
   (d) fraction limit.
   (e) none of the above.

9. Which of the following graphs illustrates Hooke’s Law (the spring force)?
   (a)
   \[ F \rightarrow x \]
   (b)
   \[ F \rightarrow x \]
   (c)
   \[ F \rightarrow x \]
   (d)
   \[ F \rightarrow x \]
   (e) None of the above.

10. Two bodies of equal mass are separated by a distance R. If you double the distance between them the new gravitational force will be
   (a) twice the old force.
   (b) half the old force.
   (c) four times the old force.
   (d) one fourth the old force.
   (e) the same as the old force.
   (f) none of the above.

11. Two bodies of equal mass are separated by a distance R. If you double each mass number then the new force will be
(a) twice the old force.
(b) half the old force.
(c) four times the old force.
(d) one fourth the old force.
(e) the same as the old force.
(f) none of the above.

12. Two bodies of equal mass are separated by a distance R. If you double one mass number then the new force will be

(a) twice the old force.
(b) half the old force.
(c) four times the old force.
(d) one fourth the old force.
(e) the same as the old force.
(f) none of the above.

13. Two bodies of equal mass are separated by a distance R. If you double each mass number and double the distance between them, the new force will be

(a) twice the old force.
(b) half the old force.
(c) four times the old force.
(d) one fourth the old force.
(e) the same as the old force.
(f) none of the above.

14. A satellite moving in a circular orbit with respect to the Earth’s center experiences a gravitational force. If the satellite is put into a new circular orbit of smaller radius, how will the gravitational force $\vec{F}_G$ and the velocity $\vec{v}$ of the satellite change, if at all?

(a) $\vec{F}_G$ is smaller, and $\vec{v}$ is smaller.
(b) $\vec{F}_G$ is smaller, and $\vec{v}$ is larger.
(c) $\vec{F}_G$ is the same, and $\vec{v}$ is the same.
(d) $\vec{F}_G$ is larger, and $\vec{v}$ is smaller.
(e) $\vec{F}_G$ is larger, and $\vec{v}$ is larger.
(f) None of the above.

15. If the mass of the earth was quadrupled and nothing else was changed,
(a) $|\vec{g}|$ would increase by a factor of 4.
(b) $|\vec{g}|$ would increase by a factor of 2.
(c) $|\vec{g}|$ would decrease by a factor of 1/2.
(d) $|\vec{g}|$ would decrease by a factor of 1/4.
(e) none of the above.

16. The value of $|\vec{g}|$ on a planet with twice Earth’s mass number and twice its radius is
   (a) four times that of Earth.
   (b) two times that of Earth.
   (c) 1/2 that of Earth.
   (d) 1/4 that of Earth.
   (e) none of the above.

17. A crumb sits a distance $r$ from the center of a CD. The coefficient of static friction between crumb and disk is $\mu_s$. If the crumb is to remain in place, what is the maximum angular velocity of the turntable?

18. A stone with mass number $m$ is whirled at the end of a string of length $\ell$ in a horizontal circle. If the tension in the cord has magnitude $|\vec{T}|$, what is the magnitude of the instantaneous rectilinear velocity?

19. What is the magnitude and direction of the force required to allow a car with mass number $m$ traveling at velocity $\vec{v}$ to safely round a curve of radius $r$?

20. Suppose a force of magnitude $F_1$ is required to stretch a spring $\Delta s_1$ from its equilibrium point. What force is required to stretch it $\Delta s_2$ from its equilibrium point?

21. What is the force of gravitational attraction between two small spheres with mass numbers $m_1$ and $m_2$, respectively, when their centers are a distance $s$ apart?

22. A newly discovered planet has twice the density $\rho_n$ of the earth, but the acceleration due to gravity on its surface $\vec{g}_n$ has exactly the same magnitude as on the surface of the earth $|\vec{g}_e|$. What is the radius of the new planet $r_n$? Let the radius of the earth be signified by $r_e$. 