Part I

1. A large barge is being pulled through the water by a small tug boat. They travel at a constant speed. From this information we know that

   (a) the force the tug boat exerts on the barge is is greater than the force the water exerts on the barge.

   (b) the force the tug boat exerts on the barge is greater than the force the barge exerts on the tug boat.

   (c) both (a) and (b) must be true.

   (d) neither (a) nor (b) are true.

2. A 50 kg gymnast slides down a vertical rope. If her acceleration is 4 m/s^2 the tension in the rope is

   (a) 200 N. (b) 300 N. (c) 500 N. (d) 700 N.

3. A car is stationary on a flat parking lot. The force of gravity acts downward on it, and an equal and opposite normal force acts upward on it. The law according to which these forces are equal and opposite is

   (a) Newton's First Law

   (b) Newton's Second Law

   (c) Newton's Third Law

   (d) Newton's Universal Law of Gravitation.

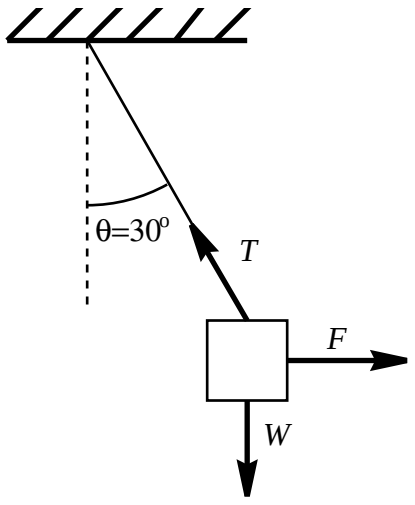
4. A block is suspended in equilibrium by an applied force of magnitude F as shown in the diagram on the right. The tension in the string is T and the weight of the block is W. Which of the following is correct.

   (a) $T > F > W$

   (b) $T > W > F$

   (c) $T < F < W$

   (d) $F < T < W$



5. A heavy ball of mass 1.00 kg is whirled at a constant speed of 2.00 ms^{-1} on the end of a string in a horizontal circle of radius 1.50 m. The work done by the tension in the string during exactly one revolution is

   (a) 0 J (b) 2.67 J (c) 8.01 J (d) 25.1 J.

6. The reason the Moon does not fall down and collide with the Earth is because

   (a) It is being pulled by the Sun and planets as well as by Earth.

   (b) The net force on it is zero.

   (c) It is beyond the main pull of Earth's gravity.

   (d) None of the above.

7. Two identical satellites orbit the earth in circular orbits. If the radius of satellite A is less than the radius of satellite B then

   (a) the kinetic energy of A is less than that of B;

   (b) the potential energy of A is less than that of B;

   (c) the acceleration of A is less than that of B;

   (d) all of the above.

8. The path of comets around the sun is elliptical and so the distance from the comet to the sun varies. The point of closest approach is called the perigee and the point of furthest reach is called the apogee. Suppose that for a particular comet the apogee is twice as far from the sun as the perigee. Comparing the strength of the force between the sun and the comet at the apogee and the perigee the force is

   (a) four times as strong at the perigee.

   (b) twice as strong at the perigee.

   (c) the same at the apogee and the perigee since acceleration constant along a closed orbit.

   (d) half as strong at the perigee.

9. A plane on the surface of a stationary aircraft carrier accelerates from rest. The plane gains a certain amount of kinetic energy and the aircraft carrier

   (a) gains more kinetic energy;

   (b) gains the same amount of kinetic;

   (c) gains less kinetic energy;

   (d) loses kinetic energy as the plane gains it.

10. A diver jumps off a tower and accelerates downwards towards the water below. When he enters the water he slows down uniformly coming to a stop before he hits the bottom of the pool. The force of the water on him as he descends is.

    (a) equal to his weight.

    (b) greater than his weight.

    (c) less than his weight.

    (d) the answer depends on his rate of deceleration.

11. A red and a blue ball with equal mass collide in a head on collision. The red ball rebounds in the opposite direction traveling at the same speed it started with. The blue ball comes to a stop. The initial momentum of the blue ball must have been

    (a) equal to the initial momentum of the red ball.

    (b) half the initial momentum of the red ball

    (c) twice the initial momentum of the red ball

    (d) The above collision is physically impossible.

12. Which line in the table below correctly identifies force, work and momentum as scalar or vector quantities

	force	**work**	**momentum**
(a)	scalar	vector	vector
(b)	vector	scalar	vector
(c)	vector	scalar	scalar
(d)	vector	vector	vector

13. If the radius of the path of a body in uniform circular motion is doubled and the *angular* velocity is kept the same then the force needed must be

    (a) half as great as before.

    (b) the same as before.

    (c) twice as large as before.

    (d) four times the size as before.

14. Which of the following could be measured in the same units as force?

    (a) momentum$\times$time

    (b) energy/distance

    (c) energy/time

    (d) momentum$\times$distance

15. In a totally inelastic collision

    (a) neither kinetic energy nor momentum are conserved.

    (b) both kinetic energy and momentum are conserved.

    (c) momentum is conserved but kinetic energy is not.

    (d) kinetic energy is conserved but momentum is not.

Part II

1. (a) Suppose a satellite with mass m orbits the Earth with period T and radius R.

   (i) If another satellite with a larger mass orbits the Earth with the same period, would the radius of the orbit be larger, smaller or the same? Explain your answer.

   (ii) If another satellite with the same mass orbits the earth with a longer period would the radius of the orbit be larger, smaller or the same? Explain your answer.

   (iii) If a small amount of air resistance were to act on the satellite describe what would happen to the period and the radius of the orbit over time. Explain your answer.

   (b) An elastic cord is fixed at one end and a disk of mass m is connected to the other end. The disc moves horizontally on a frictionless surface in uniform circular motion with radius R and period T.

   (i) If a more massive disc were rotated with the same period would the radius of motion be larger, smaller or the same? Explain your answer.

   (ii) If the disc were rotated with a longer period would the radius of motion be larger, smaller or the same? Explain your answer.

   (iii) If a small amount of friction were to act on the disc describe what would happen to the period and the radius of the circular motion over time. Explain your answer.

Part III

1. Differentiate the following functions. Show your work and simplify as far as possible

   (a) $f(x) = 3x^4 - 2\ln x - \dfrac{1}{x^2}$

   (b) $f(x) = x^2 e^{3x}$

   (c) $f(x) = \dfrac{x^2 - 1}{1 + x}$

   (d) $f(x) = \sqrt{1 - \sin^2 x}$

2. For the following rate equation find y as a function of x if $y' = \sin x - \cos x$ and $y = 2$ when $x = 0$.

3. Find the area under the curve $y = 12x - 3x^2$ between $x = 0$ and $x = 4$.