Applications of Newton's Laws Worksheet (p. 1)
All work on pages 1 and 2 needs to be done on your own paper.

Pressure

1. A stack of 5 physics books is lying on a table. Each book has a mass of 1.5 kg. The dimensions of the back cover of each book is 22 cm x 26.5 cm. *Neglect the effects of air pressure.* $g = 10\ m/s^2$
   a. What is the force exerted on the table by one book? ***15 N***
   b. What is the area of the back cover of each book in m^2? ***583 cm^2***
   c. What is the pressure exerted by one book on the table? ***0.026 N/cm^2***
   d. What is the force exerted on the table by the stack of books. ***75 N***
   e. What is the pressure exerted by the stack of books on the table? ***0.13 N/cm^2***

2. A certain Physics student weighs 145 pounds and they are standing with both feet on the floor. If the total pressure exerted on the ground by them is 7.5 lb/in^2, what is the total area of their feet contacting the ground? ***10 in^2***

Friction

3. What causes friction between two solid surfaces? After the roughness of the surfaces, what most affects the frictional force experienced?

4. What causes fluid friction? What two factors affect the amount of fluid friction experienced?

5. What is the net force on a 10 N falling object that encounters 4 N of air resistance? 10 N of air resistance?
6 N down ***zero***

6. What is the acceleration of a falling object that has reached its terminal velocity?

7. Why does a heavy parachutist fall faster than a lighter one who wears the same size parachute? This is referring to after the parachute is opened.

8. Is a skydiver who has reached her terminal speed in freefall? Explain

9. How does the weight of a falling body compare with the air resistance it encounters before it reaches terminal velocity? After?

10. Why is it that a cat that falls from the top of a 50 story building will hit the ground at the same speed as it would if it fell from the 20th story?

11. If Galileo dropped two balls from the top of the Leaning Tower of Pisa, air resistance was not really negligible. Assuming the balls were the same size and shape, one made of wood and the other of metal, which ball struck the ground first? Explain

12. What will be the acceleration of a skydiver when air resistance builds up to be half her weight?

Gravitation

13. Write the Newton's Law of Universal Gravity equation, defining all terms:

14. Complete: Gravity force is directly proportional to the ____________ of the masses and ____________ proportional to the __________ of the distance between them.

15. If the gravitational force of attraction between two objects is 100N, what would it be if the distance between them were (a) doubled (b) halved (c) tripled ?

16. If the mass of two objects is doubled but the distance between them remains the same, what happens to the force of gravitational attraction between them?

17. What is the force of gravity between a 50 kg student and a 60 kg student 2.0 meters apart?
5×10^{-8} N

Applications of Newton's Laws Worksheet (p. 2)
All work on pages 1 and 2 needs to be done on your own paper.

Circular Motion

18. What is the force that acts on an object in a circular motion? In what direction does this force act?

19. Why do you feel like you are flung sideways when your car travels around a sharp curve?

20. Swing a bucket of water around in a full circle. Does the water stay in the bucket? Explain your choice.

21. When you observe an object moving in a circle, what can you infer about the net force acting on it?

22. What holds the moon in its orbit around the earth?

23. Why must there be a force acting in order for an object to successfully make it around a curved path?

24. What causes the force on a car as it travels through a curve? Why does a car skid on an icy curve?

25. Below are a number of situations involving circular motion. In each case, identify the <u>source</u> of the force needed to keep the objects in question moving in their <u>circular</u> paths.

    Example: A <u>race car</u> going around a corner:
    <u>Friction</u> from the road holds the car in a circular path.

    a) a <u>child</u> riding on a merry-go-round:

    b) a <u>ball</u> at the end of a string being swung in a horizontal circle:

    c) a <u>sprinter</u> running around the curve at the end of the track:

    d) <u>you</u> in a car as you go over the top of a sharp bump:

    e) <u>you</u> in your seat on a roller coaster going through the bottom of a dip:

    f) a <u>child</u> being swung around in a horizontal circle by a well-meaning adult:

    g) <u>you</u> in a car going around a horizontal corner:

    h) <u>you</u> in the "Gravitron", a carnival ride where you stand inside a spinning drum and are pressed against the side:

    i) <u>Mud</u> sticking in the tread of a spinning automobile tire:

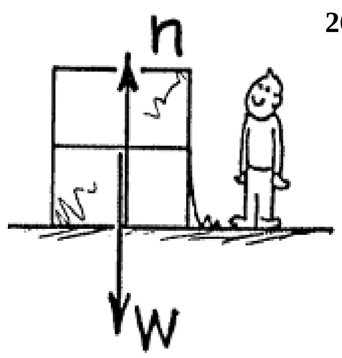
    j) <u>you</u> turning on roller skates or roller blades:

    k) <u>water</u> in a bucket being swung in a vertical circle:

    l) <u>Mars</u> going around the sun:

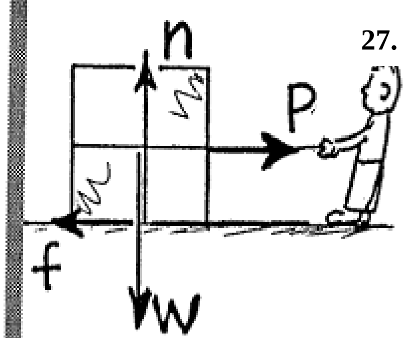
Applications of Newton's Laws Worksheet (p. 3)
All work on pages 1 and 2 needs to be done on your own paper.

Friction



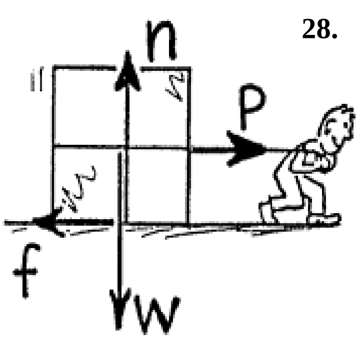
26. A crate filled with delicious junk food rests on a horizontal floor. Only gravity and the support force of the floor act on it, as shown by the vectors for weight **W** and normal force **n**.

a. The net force on the crate is (zero) (greater than zero).
b. Evidence for this is ______________________________.



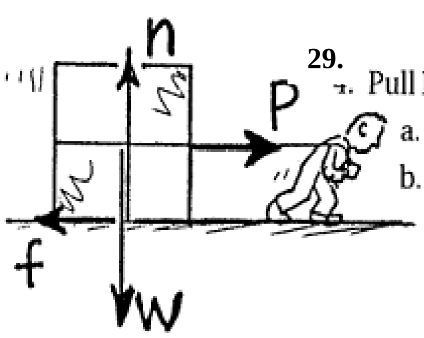
27. A slight pull **P** is exerted on the crate, not enough to move it. A force of friction **f** now acts,

a. which is (less than) (equal to) (greater than) **P**.
b. Net force on the crate is (zero) (greater than zero).



28. Pull **P** is increased until the crate begins to move. It is pulled so that it moves with constant velocity across the floor.

a. Constant velocity means acceration is (zero) (greater than zero).
b. Net force on the crate is (less than) (equal to) (greater than) zero.
c. Friction **f** is (less than) (equal to) (greater than) **P**.



29. Pull **P** is further increased and is now greater than friction **f**.

a. Net force on the crate is (less than) (equal to) (greater than) zero.
b. The net force acts toward the right, so acceleration acts toward the (left) (right).

30. If the pulling force **P** is 150 N and the crate doesn't move, what is the magnitude of **f**? __________

31. If the pulling force **P** is 200 N and the crate doesn't move, what is the magnitude of **f**? __________

32. If the force of sliding friction is 250 N, what force is necessary to keep the crate sliding at constant velocity? __________

33. If the mass of the crate is 50 kg and sliding friction is 250 N, what is the acceleration of the crate when the pulling force is 250 N? __________ 300 N? __________ 500 N? __________

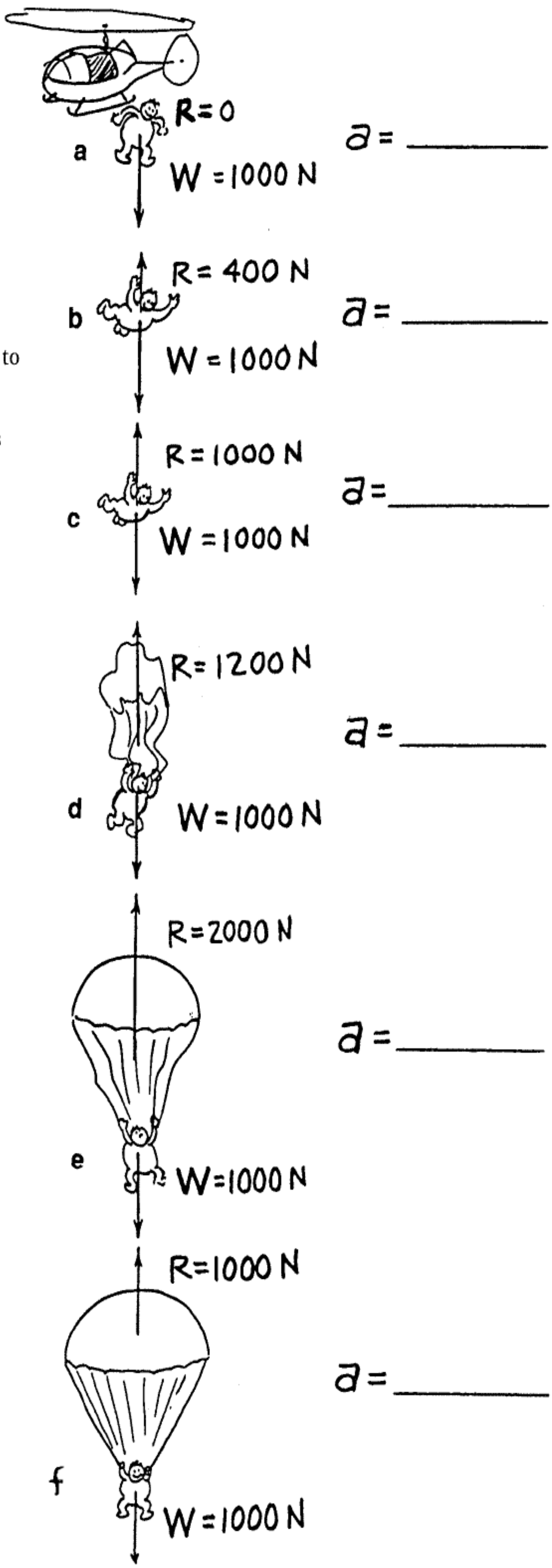
Applications of Newton's Laws Worksheet (p. 4)
All work on pages 1 and 2 needs to be done on your own paper.

Falling and Air Resistance

Bronco skydives and parachutes from a stationary helicopter. Various stages of fall are shown in positions *a* through *f*. Using Newton's 2nd law,

$$a = \frac{F_{NET}}{m} = \frac{W-R}{m}$$

find Bronco's acceleration at each position (answer in the blanks to the right). You need to know that Bronco's mass *m* is 100 kg so his weight is a constant 1000 N. Air resistance *R* varies with speed and cross-sectional area as shown.



Circle the correct answers.

34. When Bronco's speed is least, his acceleration is

    (least) (most).

35. In which position(s) does Bronco experience a downward acceleration?

    (a) (b) (c) (d) (e) (f)

36. In which position(s) does Bronco experience an upward acceleration?

    (a) (b) (c) (d) (e) (f)

37. When Bronco experiences an upward acceleration, his velocity is

    (still downward) (upward also).

38. In which position(s) is Bronco's velocity constant?

    (a) (b) (c) (d) (e) (f)

39. In which position(s) does Bronco experience terminal velocity?

    (a) (b) (c) (d) (e) (f)

40. In which position(s) is terminal velocity greatest?

    (a) (b) (c) (d) (e) (f)

41. If Bronco were heavier, his terminal velocity would be

    (greater) (less) (the same).

Conceptual PHYSICS

Applications of Newton's Laws Worksheet (p. 5)
All work on pages 1 and 2 needs to be done on your own paper.

Concept-Development Practice Page 13-2

Gravitational Interactions

The equation for the law of universal gravitation is

$$F = G\frac{m_1 m_2}{d^2}$$

where F is the attractive force between masses m_1 and m_2 separated by distance d. G is the universal gravitational constant (and relates G to the masses and distance as the constant π similarly relates the circumference of a circle to its diameter). By substituting changes in any of the variables into this equation, we can predict how the others change. For example, we can see how the force changes if we know how either or both of the masses change, or how the distance between their centers changes.

Suppose, for example, that one of the masses somehow is doubled. Then substituting $2m_1$ for m_1 in the equation gives

$$F_{NEW} = G\frac{2m_1 m_2}{d^2} = 2\left(G\frac{m_1 m_2}{d^2}\right) = 2F_{OLD}$$

So we see the force doubles also. Or suppose instead that the distance of separation is doubled. Then substituting $2d$ for d in the equation gives

$$F_{NEW} = G\frac{m_1 m_2}{(2d)^2} = G\frac{m_1 m_2}{4d^2} = \frac{1}{4}\left(G\frac{m_1 m_2}{d^2}\right) = \frac{1}{4}F_{OLD}$$

And we see the force is only 1/4 as much.

Use this method to solve the following problems. Write the equation and make the appropriate substitutions.

42. If both masses are doubled, what happens to the force?

43. If the masses are not changed, but the distance of separation is reduced to 1/2 the original distance, what happens to the force?

Applications of Newton's Laws Worksheet (p. 6)
All work on pages 1 and 2 needs to be done on your own paper.

Concept-Development Practice Page **9-2**

Acceleration and Circular Motion

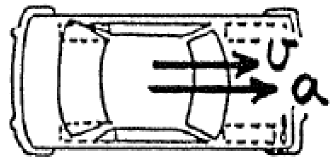
Newton's 2nd law, $a = F/m$, tells us that net force and its corresponding acceleration are always in the same direction. (Both force and acceleration are vector quantities). But force and acceleration are not always in the direction of velocity (another vector).

44. You're in a car at a traffic light. The light turns green and the driver "steps on the gas."

a. Your body lurches (forward) (not at all) (backward).

b. The car accelerates (forward) (not at all) (backward).

c. The force on the car acts (forward) (not at all) (backward).



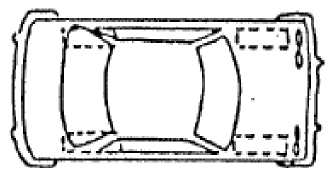
The sketch shows the top view of the car. Note the directions of the velocity and acceleration vectors.

45. You're driving along and approach a stop sign. The driver steps on the brakes.

a. Your body lurches (forward) (not at all) (backward).

b. The car accelerates (forward) (not at all) (backward).

c. The force on the car acts (forward) (not at all) (backward).



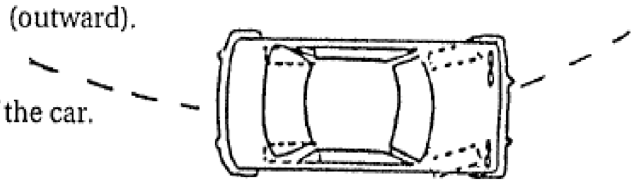
The sketch shows the top view of the car. Draw vectors for velocity and acceleration.

46. You continue driving, and round a sharp curve to the left at constant speed.

a. Your body leans (inward) (not at all) (outward).

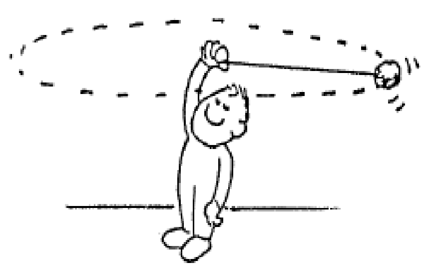
b. The direction of the car's acceleration is (inward) (not at all) (outward).

c. The force on the car acts (inward) (not at all) (outward).



Draw vectors for velocity and acceleration of the car.

47. In general, the directions of lurch and acceleration, and therefore the directions of lurch and force, are (the same) (not related) (opposite).



5. The whirling stone's direction of motion keeps changing.

a. If it moves faster, its direction changes (faster) (slower).

b. This indicates that as speed increases, acceleration (increases) (decreases) (stays the same).

48. Consider whirling the stone on a shorter string—that is, of smaller radius.

a. For a given speed, the rate that the stone changes direction is (less) (more) (the same).

b. This indicates that as the radius decreases, acceleration (increases) (decreases) (stays the same).

***Conceptual* PHYSICS**