

# Assessment Standards for Nelson Resources

## 1. Curriculum Congruency

Assessment strategies and tools are matched to the Ontario curriculum with respect to performance standards (such as Achievement Levels) and content standards (such as Curriculum Expectations).

## 2. Manageability

Each resource provides teachers with an efficient and manageable approach to assessment that includes diagnostic, formative, and summative components.

## 3. Variety of Tools

Teachers receive a variety of assessment tools, including: rubrics, checklists, tracking sheets, and answer keys.

## 4. Clear Criteria

Assessment criteria are clearly indicated so that teachers and students know what is expected in each assessment task.

## 5. Opportunities for Self-Assessment

Clear directions are provided to involve students and, where appropriate, parents in the assessment process.

## Questions Reflect the Achievement Chart Categories

A balance of **Understanding Concepts**, **Applying Inquiry Skills**, and **Making Connections** questions appear throughout the text.

**Section 3.2 Questions**

**Understanding Concepts**

1. What is the magnitude of the force of gravitational attraction between a 55-kg student and a 65-kg student, whose centres are 1.0 km apart?
2. At a certain instant, a 255-kg meteoroid moving toward Earth is located 6.75 Mm from Earth's centre. What is the magnitude of the force of gravitational attraction between the two bodies? (Earth's mass is  $5.98 \times 10^{24}$  kg.)
3. Is it possible for a body to exist somewhere in the universe that has no forces whatsoever acting on it? Explain your answer.

**Applying Inquiry Skills**

4. Describe how you would use a globe to illustrate the orbit of a geosynchronous communications satellite.

**Making Connections**

5. Research the meanings and causes of "spring tides" and "neap tides." Follow the links for Nelson Physics 11, 3.2. Draw diagrams to show what you discover.  
**GO TO** [www.science.nelson.com](http://www.science.nelson.com)
6. Astronomers have used equations derived by Sir Isaac Newton to estimate that the Milky Way Galaxy has a mass of approximately  $4 \times 10^{41}$  kg. If the mass of our Sun is  $2 \times 10^{30}$  kg, how many stars are there in our galaxy? Assume for this question that all stars have the same average mass and that the masses of planets are negligible.

(continued)

In the Chapter 2 opener activity, Table 1 shows data that were collected in this way, and Figure 4 shows that the graph of these data yields a straight line. The slope of the line in Figure 4 is

$$\text{slope} = \frac{\Delta F_g}{\Delta m} = \frac{8.0 \text{ N} [1]}{1.0 \text{ kg}} = 8.0 \text{ N/kg} [1]$$

The slope gives the gravitational field strength on Earth's surface in newtons per kilogram. Where have you seen the number 9.8 before? This is the acceleration due to gravity  $9.8 \text{ m/s}^2 [1]$ . It is left as an exercise to show that  $\text{N/kg}$  and  $\text{m/s}^2$  are equivalent.

Since the gravitational field strength and the acceleration due to gravity are numerically equal, the same symbol,  $g$ , is used for both. Therefore, on Earth's surface,  $g = 9.8 \text{ N/kg} [1]$ , or  $g = 9.8 \text{ m/s}^2 [1]$ .

The gravitational field strength can be applied using the equation for Newton's second law of motion,  $F_g = mg$  to determine the force acting on an object at Earth's surface.

**Sample Problem 1**  
The maximum train load pulled through the Channel, the train tunnel under the English Channel that links England and France, is 2424 t. Determine the force of gravity on this huge mass.

**Solution**  
 $F_g = mg [1]$   
 $2424 \text{ t} = 2424 \times \frac{1000 \text{ kg}}{1 \text{ t}} = 2.424 \times 10^6 \text{ kg}$   
 $F_g = mg$   
 $F_g = (2.424 \times 10^6 \text{ kg})(9.8 \text{ N/kg}) [1]$   
 $F_g = 2.4 \times 10^7 \text{ N} [1]$   
The force on the load is  $2.4 \times 10^7 \text{ N} [1]$ .

**Practice**

**Understanding Concepts**

- Show that  $\text{N/kg}$  is equivalent to  $\text{m/s}^2$ .
- The average mass of a basketball is 0.63 kg. What is the force of gravity acting on the ball?
- The force of gravity on the heaviest person in history is about 6.2 kN [1]. Determine the mass of this record holder in kilograms.
- The force of gravity on a 25 kg spacecraft on the Moon's surface is 408 N [1].
  - What is the gravitational field strength there?
  - What is the acceleration of a free-falling object on the surface of the Moon?
- Assume you are in a space colony on Mars, where the gravitational field strength is  $3.7 \text{ N/kg} [1]$ . What is the force of gravity on you?

**Answers**

- $1 \text{ N/kg} = 1 \frac{\text{kg} \cdot \text{m/s}^2}{\text{kg}} = 1 \text{ m/s}^2$
- $6.2 \text{ N} [1]$
- $6.2 \times 10^3 \text{ kg} [1]$
- (a)  $1.63 \text{ N/kg} [1]$   
(b)  $1.63 \text{ m/s}^2 [1]$

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## Section Questions

Section Questions are presented when it is convenient to assess a cluster of expectations that are "finished" in their development. They are intended to be used largely for formative or summative assessment and are categorized to reflect the Achievement Chart.

**NOTE:** Answers to Section Questions are not presented anywhere in the Student Text. Solutions and sample written answers are presented in the Solutions Manual.

## Practice Questions

Practice Questions are presented in the middle of a section, offering students the opportunity to practise working with the terms, mathematical or problem-solving techniques, skills, or concepts presented in the text. These questions often follow a Sample Problem and are intended to be used largely for formative assessment.

**NOTE:** Answers to Practice Questions, when they are numerical, are presented in the margin beside the questions. Solutions and sample written answers are presented in the Solutions Manual.

...of orbiting another object maintains its orbit by constantly free falling toward the central body. For example, the International Space Station and its contents constantly free fall toward Earth.

**Section 3.1 Questions**

**Understanding Concepts**

- In a videotape of the Apollo astronauts on the Moon, it seems that the astronauts are moving about in slow motion. Explain why this is the case.
- Why is the gravitational field strength halfway up Mount Everest the same as at sea level on the equator?
- Why is the gravitational field strength at the South pole less than that at the North Pole? (Hint: Look at the globe to see which pole is at sea level and which is on a thick ice shelf.)
- Suppose you wanted to make some money by purchasing precious materials such as gold at one altitude and selling them for the same price in dollars per newton at another altitude. Describe the conditions that would favour your "buy high and sell low" strategy.
- What is the force of gravity at Earth's surface on each of the following masses?
  - 25.0 kg
  - 45 g
  - 2.00 t
- What is the weight of each of the following masses at Earth's surface?
  - 25 kg
  - 102 kg
  - 12 mg
- Use these magnitudes of the forces of gravity at Earth's surface to determine the masses of the objects on which they act.
  - 0.48 N
  - 62 N
  - 4.5 MN
- Copy Table 4 into your notebook and complete it for a 5.7 kg instrument on each planet.

(continued)

**Did You Know?**

**Students on a Training Flight**

High school students are sometimes allowed to train aboard the International Space Station (the ISS) aboard a training airplane (the KC-135 aircraft). Follow the link for further information. It is a real-life experience about a student flight conducted on April 11, 1999.

[www.nasa.gov/missionmain](http://www.nasa.gov/missionmain)

**Table 4**

Planet	$F_g(\text{N})$	$g(\text{N/kg})$
Mars	188	?
Jupiter	62	?
Venus	—	—

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## Chapter and Unit Review Questions

Chapter and Unit Review Questions can be used for more formative assessment, and questions are categorized to reflect the Achievement Chart.

**NOTE:** Answers to Chapter and Unit Review Questions, when they are numerical, are presented in Appendix D at the back of the student text.

**Chapter 3 Review**

**Understanding Concepts**

- Sketch a graph to show how the first variable in the list below depends on the second one, and state the corresponding proportionality statement.
  - the gravitational field strength surrounding an object; the force the object exerts on surrounding objects
  - the gravitational field strength of a body; the mass of the body
  - the force of gravity on an object; the distance of the object from the body exerting the force of gravity
- Determine the book's acceleration while it is sliding on its own.
  - Will the book slide off the end of the table? Show your calculations.
- A 950 kg communications satellite in synchronous orbit 42 000 km from Earth's centre has a period of 24 h. Placed in orbit above the equator and moving in the same direction as Earth is rotating, it stays above the same point on Earth at all times. This makes it useful for the reception and transmission of telephone.
  - Calculate the satellite's orbital speed.
  - Calculate the satellite's centripetal acceleration.
  - Calculate the satellite's orbital period in seconds.
- Which variable is dependent? independent?
  - Plot a graph of the data and determine the slope of the line best fit to the graph. State what the slope represents.
  - Calculate an average and interpolation and extrapolate.
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**Applying Inquiry Skills**

- Figure 8 shows a device that can be used as an accelerometer. Predict how the ball in the water will move if it is left in each of the following situations:
  - the car is accelerating forward
  - the car is accelerating backward
  - the car is moving at a constant velocity
  - the car is turning to the right
- Describe the disadvantages of exceeding a speed limit by a large amount.
- Figure 7 shows three possible arrangements of a rafter trough installed on a shelf. Assuming the trough is on the right side in each design, which design would you recommend? Use physics principles to explain why.
  - about
  - present

**Unit 1 Review**

**Understanding Concepts**

- Set up a five-column table with the following headings: Quantity, Symbol, Type of Quantity, SI Unit, Typical Value (order or ratio).
- Complete the table for the following quantities: distance, time interval, average speed, position, displacement, average velocity, average acceleration, net force, mass, and coefficient of kinetic friction.
- The Yukon Quest, an annual dog-dog sled race between Whitehorse in Yukon and Fairbanks in Alaska, covers a grueling distance of 1610 km. Assuming that the average speed of the dog team that set a course record is 12.8 km/h, determine the best time for this race. Express your answer in hours, hours, and minutes.
- The highest average lap speed on a closed circuit in motorsporting is about 72 m/s or 258 km/h. If a cyclist takes 56 s to complete one lap of the circuit, track what the track's circumference?
- Under what condition(s) will the magnitude of the displacement of a moving object be the same as the distance it travels?
- The distance between bases on a baseball diamond is 27.4 m. Use a scale diagram, the Pythagorean theorem, or trigonometry to find the magnitude of a runner's displacement from home plate to second base.
- Toronto is about 50 km from Hamilton. A freight train travels from Hamilton to Toronto at an average speed of 50 km/h. At the same time, a passenger train travels from Toronto to Hamilton at an average speed of 75 km/h. Find the time, in minutes, before the trains meet one another. (Assume two significant digits.)
- The distance depicted in Figure 1 shows the path of a team in a car rally held in a rural area where the speed limit is 80 km/h. In the car rally, points are designated for anyone determined to be breaking the speed limit.
  - Calculate the average speed for the team.
  - Calculate the average velocity for the team.
  - Calculate the average acceleration for the team.
- A 65 t electric train accelerates uniformly from a station with the train motion depicted in the graph in Figure 2. (Recall that  $1 = 1.0 \times 10^3 \text{ kg}$ .)
  - Use the information in the velocity-time graph to generate the position-time and acceleration-time graphs of the motion.
  - Determine the net force acting on the train during the uniform acceleration portion of the motion.
- A 650-N student is rollerblading at a velocity of 7.8 m/s [W] when the student slips and becomes tumbled along the trail, coming to a stop in 0.95 s.
  - Determine the student's average acceleration.
  - Draw an FBD of the student sliding on the trail.
  - What is the kinetic friction on the student's feet?
  - Determine the coefficient of kinetic friction between the student and the trail.
- Write a test on this chapter a student could not do.
  - Write a question that could be used as an accelerometer. Predict how the ball in the water will move if it is left in each of the following situations:
    - the car is accelerating forward
    - the car is accelerating backward
    - the car is moving at a constant velocity
    - the car is turning to the right
  - Describe the disadvantages of exceeding a speed limit by a large amount.
  - Figure 7 shows three possible arrangements of a rafter trough installed on a shelf. Assuming the trough is on the right side in each design, which design would you recommend? Use physics principles to explain why.
    - about
    - present
- Calculate the magnitude of the force of gravity acting on a 140 kg weighing 800 kg above Earth's surface.
  - Compare your answers to (a) and (b).
  - Based on the results, derive an equation that could be used to determine Earth's mass.
- Figure 3 shows a cart with a battery-operated fan on it. The cart has a slot into which a card can be inserted. Predict and explain what will happen if the fan is turned on when the card is
  - about
  - present
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- Determine the magnitude of the force of gravity acting on a 140 kg weighing 800 kg above Earth's surface.
  - Compare your answers to (a) and (b).
  - Based on the results, derive an equation that could be used to determine Earth's mass.
- An applied horizontal force of magnitude 91 N is needed to push a 2.0 kg lamp across a table at a constant velocity.
  - Determine the coefficient of kinetic friction between the lamp and the table.
  - How would the coefficient of static friction compare to your answer in (a)? Why?
- A 5.0 kg object made of one material is being pulled at a constant velocity along a table made of another material. The coefficient of sliding friction between these two materials is 0.25. What is the magnitude of the force of friction?
  - Determine the force applied to the book by the student.
  - Determine the acceleration of the book while the student is applying the push.
  - Calculate the maximum velocity reached by the book.
  - Draw an FBD of the book after the force is removed and the book is sliding on its own.

**Figure 1**

**Figure 2**

**Figure 3**

**Figure 4**

**114 Unit 1**

**Forces and Motion 115**

The Nelson Physics 11 Computerized Assessment Bank includes 1500 questions, each correlated to a specific expectation(s) in the curriculum and categorized to reflect the Achievement Chart categories.

# Are You Ready? and Unit Performance Task


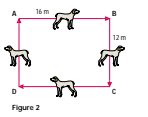
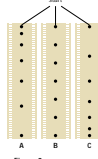
The **Are You Ready?** section is a diagnostic “pre-test” presented at the beginning of each unit. It can be used by students and teachers to help identify areas where students may have misconceptions about concepts or skills or have forgotten key learnings from earlier grades. In this feature, students are asked questions, usually in a visual format, about prerequisite concepts or skills (including math and lab safety) for each unit.

Unit  
**1**

Forces and Motion

## Are You Ready?

**Knowledge and Understanding**

- Figure 1 shows the motion of a car along a straight road. The images are taken at time intervals of 1.0 s. Describe the motion of the car using your vocabulary of motion.
 
- A playful dog runs along the path shown in Figure 2, starting at A and following through all arrows. The distance from A to B is 16 m, and the distance from B to C is 12 m. The total time the dog takes to go from A along the path back to A again is 18 s.
  - State the compass direction the dog is moving in each part of the run.
  - Determine the total distance travelled by the dog.
  - What is the net displacement of the dog over the entire path.
  - Calculate the dog's average speed of motion.
  - What is the dog's average velocity for the entire trip?
- A “physics” golf ball, attached with a light that flashes regularly with time, is dropped in a dark room from shoulder height to the floor. Which set of dots representing the flashing of light in Figure 3 would you observe in a photograph of the golf ball's downward motion? Explain your choice.
 

**Inquiry and Communication**

- Refer to Figure 4.
  - Name all the forces on the diver at position A, at position B.
  - Draw a sketch of the diving board with the diver on it, and label the following in your diagram: tension in the board, compression in the board, the force of gravity on the diver, and the force of the board acting on the diver.
  - Which of the forces you labelled in (b) is a non-contact force? Explain how you can tell.
- The scale used to draw the two geometric shapes in Figure 5 is 1.0 cm = 1.0 m. Determine the surface area of each shape.
- The motion of three cars, L, M, and N, are illustrated by the graphs in Figure 6. Compare the times of travel and average speeds of the three cars.
- Calculate the slope of the line and the area under the line on the graph in Figure 7. State what the slope and area represent.

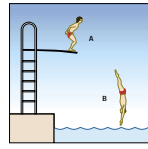
**Table 1**

Group	A	B	C	D
Density	0.36 g/cm <sup>3</sup>	0.737 788 g/cm <sup>3</sup>	1.1 g/cm <sup>3</sup>	0.36 g/cm <sup>3</sup>


**Table 2**

Time (s)	0	1.0	2.0	3.0	4.0	5.0
Displacement (m)	0	4.0	8.0	12.0	16.0	20.0

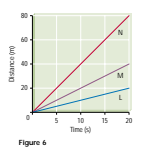
**Figure 4** For question 4



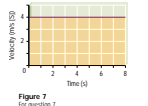
**Figure 5** For question 5



**Figure 6** For question 6



**Figure 7** For question 7



Unit 1

Performance Task

## Motion and Space Exploration

Galileo and Newton, who led the way in understanding the relationship between forces and motion, would be impressed by recent achievements in space exploration. Humans have landed on the Moon, launched communication and telescope satellites, and sent space probes to explore other planets and the Sun. In the future, humans may colonize other bodies in the solar system. Mars will likely be one of them. Robots and rovers have been sent to Mars to discover features that must be fully understood before humans can land on Mars. However, the technological challenges of sending probes and robots to Mars are immense. In the spring of 2000, a disaster occurred when the Mars Polar Lander (Figure 1) went missing for reasons still not fully known. One assumption of the disappearance is that the Lander crashed into a sloped surface and tumbled onto its side, making the communications system useless.



**Figure 1**  
The robot carrying the Mars Polar Lander was launched from Earth in January 1999. The mission of the Polar Lander was to search for water and possible evidence of some form of life that might have existed on Mars. At the 260 kg four-lander was descending to Mars' surface 15 months later, something went wrong, ending the Polar Lander's communication with Earth.

Perhaps the Polar Lander was designed to land only on a relatively flat surface. But whatever the reason for the failure, the costs were enormous and the need for a better design and more tests became obvious. These procedures are just part of the process of technological development: a need is identified, design, construction, and tests are carried out, a new problem arises, which identifies a new need, design changes are made to accommodate the new need.

In this Unit Task, you are expected to demonstrate an understanding of the relationship between forces and motion and apply the skills of inquiry and communication that you have developed both in this unit and in other science courses.

**Spinoffs**

The space exploration programs of the past half century have resulted in many designs, discoveries, and innovations that have been applied to everyday life. These spinoffs include freeze-dried foods, robotic tools used in industry, hard plastics used in safety helmets and in-line skates, and Velcro. Your design can also have spinoffs. For example, your ideas may be applied to create safer helmets for sports activities or restraint systems for automobiles.

**Assessment**

Your completed task will be assessed according to the following criteria:

**Process**

- Draw up detailed plans of the technological design, tests, and modifications.
- Choose appropriate materials for the Lander.
- Carry out the construction, tests, and modification of the Lander.
- Analyze the process (as described in Analysis).
- Evaluate the task (as described in Evaluation).

**Product**

- Submit the design and testing plans of the Lander.
- Demonstrate an understanding of the process of technological design and related physics concepts, principles, laws, and theories.
- Use terms, symbols, equations, and SI metric units correctly.
- Prepare a final product of the Lander to be tested.

**Clear Criteria**

Assessment criteria are clearly indicated so that teachers and students know what is expected in each assessment task.

## Unit Performance Task

Each unit ends with a performance task that can be used for evaluating a significant “chunk” of the achievement expectations addressed in the unit. It can be a design-and-do investigation; a design-and-build activity; or a case study presenting a real-world process or system with STSE implications.

