

SPH4U UNIVERSITY PHYSICS

DYNAMICS
Introduction
(P.2-5)

Dynamics (Forces & Motion)

Spectators are mesmerized by trapeze artists making perfectly timed releases, gliding through graceful arcs, and intersecting the paths of their partners. An error in timing and a graceful arc could become a trajectory of panic. Trapeze artists know that tiny differences in height, velocity, and timing are critical.



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Dynamics (Forces & Motion)

Swinging from a trapeze, the performer forces their body from its natural straight-line path. Gliding freely through the air, they are subject only to gravity. Then, the outstretched hands of their partner make contact, and the performer is acutely aware of the forces that change their speed and direction.



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Overall Expectations

By the end of this unit, students will:

1. analyse technological devices that apply the principles of the dynamics of motion, and assess the technologies' social and environmental impact;
2. investigate, in qualitative and quantitative terms, forces involved in uniform circular motion and motion in a plane, and solve related problems;
3. demonstrate an understanding of the forces involved in uniform circular motion and motion in a plane.

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Big Ideas

Concepts that students should retain long after this course are:

- Forces affect motion in predictable and quantifiable ways.
- Forces acting on an object will determine the motion of that object.
- Many technologies that utilize the principles of dynamics have societal and environmental implications.

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Getting Started: Useful Concepts & Skills

CONCEPTS REVIEW

1. A 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 would you observe in a photograph of the golf ball's downward motion? Explain your choice.

A – As the golf ball falls (gravity) its velocity increases so the distance between each flash increases.

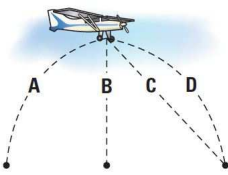
A B C

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Getting Started: Useful Concepts & Skills

CONCEPTS REVIEW

2. A photographer accidentally drops a camera out of a small airplane as it flies horizontally. As seen from the ground, which path would the camera most closely follow as it fell?



D – parabolic motion (if we ignore air resistance the horizontal motion is constant and the vertical motion is affected by gravity)

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Getting Started: Useful Concepts & Skills

CONCEPTS REVIEW

3. A golf pro drives a ball through the air. Which of the following correctly lists the force(s) acting on the golf ball for the entirety of its flight?

- (a) force of gravity only
- (b) force of gravity and the force of the "hit"
- (c) force of gravity and the force of air resistance
- (d) force of gravity, the force of the "hit," and the force of air resistance

(c) force of gravity and the force of air resistance

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Getting Started: Useful Concepts & Skills

CONCEPTS REVIEW

4. Why does a child on a toboggan fall backward when the toboggan is given a sharp tug?


law of inertia – objects in motion tend to stay in motion and objects at rest tend to stay at rest

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Getting Started: Useful Concepts & Skills

CONCEPTS REVIEW

5. Student A and student B sit in identical office chairs facing each other, as illustrated. Student A, who is heavier than student B, suddenly pushes with his feet, causing both chairs to move. Which of the following occurs?



(a) Neither student applies a force on the other.
 (b) A exerts a force on B, but A experiences no force.
 (c) Each student applies a force, but A exerts a larger force.
 (d) The students exert the same amount of force on each other.


(d) The students exert the same amount of force on each other.

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Getting Started: Useful Concepts & Skills

CONCEPTS REVIEW

6. Which of Newton's laws is this an example of?




Newton's 3rd Law ($F_{\text{action}} = -F_{\text{reaction}}$)

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Getting Started: Useful Concepts & Skills

CONCEPTS REVIEW

7. (a) If the flooring surface and office chairs are identical, which student will accelerate quicker? Recall $m_A > m_B$
 (b) Which of Newton's laws did you use to make this decision?
 (c) What is Newton's first law? Provide an example.



(a) B
(b) Newton's 2nd Law ($F_{\text{net}} = ma$)
(c) Law of Inertia – answers will vary

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Getting Started: Useful Concepts & Skills

SKILLS REVIEW

8. A dog runs along the path shown, starting at A. The total time the dog takes to go from A along the path back to A again is 16 s.

(a) Determine the total distance travelled by the dog.

(a) 56 m

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SKILLS REVIEW

8. A dog runs along the path shown, starting at A. The total time the dog takes to go from A along the path back to A again is 16 s.

(b) Calculate the dog's average speed of motion.

(b) 3.5 m/s

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SKILLS REVIEW

8. A dog runs along the path shown, starting at A. The total time the dog takes to go from A along the path back to A again is 16 s.

(c) What is the net displacement of the dog over the entire run?

(c) 0 m

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Getting Started: Useful Concepts & Skills

SKILLS REVIEW

8. A dog runs along the path shown, starting at A. The total time the dog takes to go from A along the path back to A again is 16 s.

(d) What is the dog's average velocity for the entire trip?

(d) 0 m/s

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SKILLS REVIEW

9. The three lines on the graph represent the motion of three objects.

(a) Which object has travelled farthest at time $t = 5$ s?

(a) object 1

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SKILLS REVIEW

9. The three lines on the graph represent the motion of three objects.

(b) How far has each object travelled at time $t = 3$ s?

(b) $d_1 = 12$ m
 $d_2 = 7.0$ m
 $d_3 = 6.0$ m

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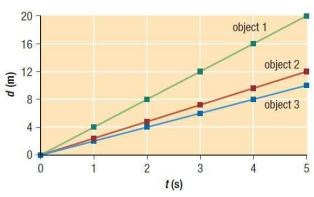
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SKILLS REVIEW

9. The three lines on the graph represent the motion of three objects.

(c) What is the slope of each line?

(c) $m_1 = 4.0 \text{ m/s}$
 $m_2 = 2.4 \text{ m/s}$
 $m_3 = 2.0 \text{ m/s}$



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SKILLS REVIEW

10. A 20 g mass and a 50 g mass are dropped from rest from the same height above the floor.

(a) If we ignore air resistance, which mass will hit the floor first?
 (b) What is the weight of the 20 g mass?

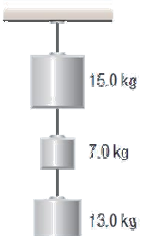
(a) Both will hit the floor at the same time.
 (b) 0.196 N (Recall $F_g = \text{“weight”}$)

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SKILLS REVIEW

11. The following diagram shows three masses connected by wires and hung vertically. Draw a FBD for each mass, and determine the tensions in the three wires.



$m = 15.0 \text{ kg}$ $F_{\text{tension}} = 343 \text{ N}$
 $m = 7.0 \text{ kg}$ $F_{\text{tension}} = 196 \text{ N}$
 $m = 13.0 \text{ kg}$ $F_{\text{tension}} = 127 \text{ N}$

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