Topic 2B: Acceleration due to gravity

Skill 14: Dropped objects

For all questions assume air resistance and friction to be negligible forces, unless otherwise specified.

__ 41. If a freely falling object were somehow equipped with a speedometer, the speed would increase each second by about

a. 5. m/s.
b. 10. m/s.
c. 15. m/s.
d. a variable amount.
e. It depends on its initial speed.

__ 42. If a freely falling object were somehow equipped with an odometer to measure the distance it travels, then the distance it travels each succeeding second would be

a. the same.
b. less than the previous second.
c. greater than the previous second.
d. The distance cannot be predicted.

__ 43. Starting from rest, a freely-falling object will fall, in 10. seconds, a distance of about

a. 10. m.
b. 50. m.
c. 100. m.
d. 500. m.
e. more than 500. m.

For the following problems you may use a value of **g** = 10 m/s/s

44. A stone dropped from the top of a building strikes the ground in 4 s. How tall is the building?

$d = ?$
$t = 4s$
$V_i = 0$
$a = 10 m/s/s$

$d = V_i t + \frac{1}{2} a t^2$
$d = \frac{1}{2}(10 m/s/s)(4s)^2$
$d = 80 m$

45. A dare-devil sky diver jumps from an airplane traveling at a height of 400 meters. If her parachute must open at 200 meters above ground, how much time will she be in a free-fall?

$d = 200m$
$V_i = 0$
$t = ?$
$a = 9.81 m/s^2 = 10 m/s^2$

$d = \frac{1}{2} a t^2$
$t = \sqrt{\frac{2d}{a}}$
$t = \sqrt{\frac{2(200m)}{10}} = 6.3s$

Topic 2B - Skill 14 and 15
Free Fall

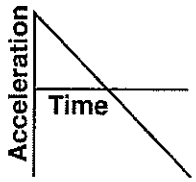
46. A rock is dropped from a bridge. What happens to the magnitude of the acceleration and the speed of the rock as it falls? [Neglect friction.]

A) Both acceleration and speed increase.
B) Both acceleration and speed remain the same.
C) Acceleration increases and speed decreases.
D) Acceleration remains the same and speed increases.

$a = 9.81 m/s^2$

$V_f = at$

47. Which graph best represents the relationship between the acceleration of an object falling freely near the surface of Earth and the time that it falls?

A)


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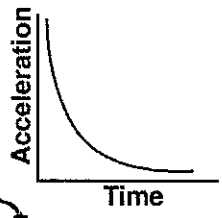

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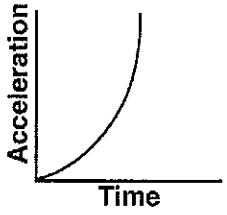
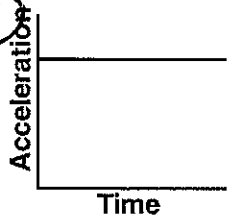


D)


Topic 2B - Skill 14 and 15

48. An object is dropped from rest and falls freely 20. meters to Earth. When is the speed of the object 9.8 meters per second?

A) during the entire first second of its fall
B) at the end of its first second of fall
C) during its entire time of fall
D) after it has fallen 9.8 meters

$V_f = 9.80\ m/s \quad t = 1s$
$t = ?$
$a = 9.81\ m/s^2$
$V_i = 0$

49. A 4.0-kilogram rock and a 1.0-kilogram stone fall freely from rest from a height of 100 meters. After they fall for 2.0 seconds, the ratio of the rock's speed to the stone's speed is

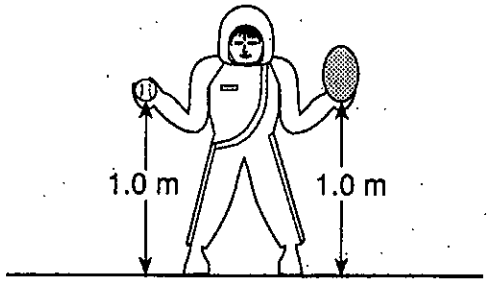
A) 1:1 B) 1:2 C) 2:1 D) 4:1

50. A rock dropped off a bridge takes 5 seconds to hit the water. Approximately what was the rock's velocity just before impact?

A) 5 m/s B) 2 m/s
C) 50 m/s D) 125 m/s

$V_f = V_i + at$
$V_f = 0 + (9.81\ m/s^2)(5s)$
$V_f = 49\ m/s$

51. As shown in the diagram below, an astronaut on the Moon is holding a baseball and a balloon. The astronaut releases both objects at the same time.



What does the astronaut observe?
[Note: The Moon has no atmosphere.]

A) The baseball falls slower than the balloon.
B) The baseball falls faster than the balloon.
C) The baseball and balloon fall at the same rate.
D) The baseball and balloon remain suspended and do not fall.

52. Which is constant for a freely falling object?

A) displacement B) speed
C) velocity D) acceleration

53. A book of mass m falls freely from rest to the floor from the top of a desk of height h. What is the speed of the book upon striking the floor?

A) $\sqrt{2gh}$ B) $2gh$
C) mgh D) mh

$a = g$
$d = h$
$V_i = 0$
$V_f = ?$

$V_f^2 = V_i^2 + 2ad$
$V_f^2 = 2gh$
$V_f = \sqrt{2gh}$

54. A baseball dropped from the roof of a tall building takes 3.1 seconds to hit the ground. How tall is the building? [Neglect friction.]

A) 15 m
B) 30. m
C) 47 m
D) 94 m

$d = \frac{1}{2}at^2$

$d = \frac{1}{2}(9.8 m/s^2)(3.1s)^2$

55. What is the speed of a ~~2.5-kilogram~~ mass after it has fallen freely from rest through a distance of 12 meters?

A) 4.8 m/s
B) 15 m/s
C) 30. m/s
D) 43 m/s

$V_f = ?$
$a = 9.81 m/s^2$
$d = 12m$
$V_i = 0$

$V_f^2 = V_i^2 + 2ad$
$V_f^2 = 0 + 2(9.81 m/s^2)(12m)$
$V_f = 15.3 m/s$

56. A rock falls freely from rest near the surface of a planet where the acceleration due to gravity is 4.0 meters per second^2. What is the speed of this rock after it falls 32 meters?

A) 8.0 m/s
B) 16 m/s
C) 25 m/s
D) 32 m/s

$V_i = 0$
$V_f = ?$
$a = 4 m/s^2$
$d = 32m$

$V_f^2 = V_i^2 + 2ad$
$V_f^2 = 0 + 2(4 m/s^2)(32m)$

57. A ~~5.0-kilogram sphere~~, starting from rest, falls freely 22 meters in 3.0 seconds near the surface of a planet. Compared to the acceleration due to gravity near Earth's surface, the acceleration due to gravity near the surface of the planet is approximately

A) the same
B) twice as great
C) one-half as great
D) four times as great

$d = \frac{1}{2}at^2$
$22m = \frac{1}{2}a(3s)^2$
$a = 4.9 m/s^2$

58. An astronaut standing on a platform on the Moon drops a hammer. If the hammer falls 6.0 meters vertically in 2.7 seconds, what is its acceleration?

A) 1.6 m/s^2
B) 2.2 m/s^2
C) 4.4 m/s^2
D) 9.8 m/s^2

$d = \frac{1}{2}at^2$
$6m = \frac{1}{2}(a)(2.7s)^2$

59. A rock falls from rest a vertical distance of 0.72 meter to the surface of a planet in 0.63 second. The magnitude of the acceleration due to gravity on the planet is

A) 1.1 m/s^2
B) 2.3 m/s^2
C) 3.6 m/s^2
D) 9.8 m/s^2

$d = .72m$
$t = .63s$
$a = ?$
$V_i = 0$

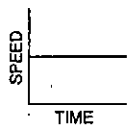
$d = \frac{1}{2}at^2$
$\frac{2d}{t^2} = a$

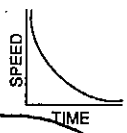
Topic 2B - Skill 14 and 15

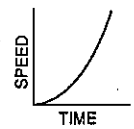
60. An object dropped from rest will have a velocity of approximately 30. meters per second at the end of

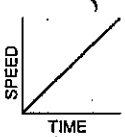
A) 1.0 s B) 2.0 s C) 3.0 s D) 4.0 s

61. Which graph best represents the motion of a freely falling body near the Earth's surface?

A) 

B) 

C) 

D) 

0=0s
10m/s=1s
20m/s=2s
30m/s=3s

62. A freely falling object near the Earth's surface travels downward at a constant

A) acceleration of 1.00 m/s^2
B) acceleration of 9.81 m/s^2
C) velocity of 1.00 m/s
D) velocity of 9.81 m/s

63. An object, initially at rest, falls freely near the Earth's surface. How long does it take the object to attain a speed of 98 meters per second?

A) 0.1 sec B) 10 sec
C) 98 sec D) 960 sec

$V_i = 0$
$V_f = 98 m/s$
$a = 9.81 m/s^2$
$t = ?$

$t = \frac{\Delta V}{a} = \frac{98 m/s}{9.8 m/s^2}$
$= 10s$

64. As a body falls freely near the surface of the Earth, its acceleration

A) decreases
B) increases
C) remains the same

65. If the mass of an object were doubled, its acceleration due to gravity would be

A) halved B) doubled
C) unchanged D) quadrupled

66. A rock falls from rest off a high cliff. How far has the rock fallen when its speed is 39.2 meters per second? [Neglect friction.]

A) 19.6 m B) 44.1 m
C) 78.3 m D) 123 m

$V_f = 39.2 m$
$V_i = 0$
$a = 9.81 m/s^2$
$d = ?$

$V_f^2 = V_i^2 + 2ad$
$(39.2 m/s)^2 = 0 + 2(9.81 m/s^2)d$

Topic 2B - Skill 14 and 15

67. An acorn dropped from rest by a squirrel, falls approximately 45 cm in 0.3 seconds. How much time will it take for the acorn to fall 90 cm?

A) 0.6 seconds B) 0.18 seconds
C) 0.42 seconds D) 0.3 seconds

$t = \sqrt{\frac{2(.9m)}{9.81 m/s^2}}$ or $\times\sqrt{2}$

68. A space craft drops a sensor onto the Comet Tempel I from a height of 20m. The fall takes 14 seconds. What is the landing speed of the sensor? [Hint: This is a multi-step problem]

A) 2.8 m/s B) 0.2 m/s
C) 1.4 m/s D) 0.7 m/s

$d = 20m$, $t = 14s$, $v_i = 0$, $a = ?$

$d = \frac{1}{2}at^2$
$20m = \frac{1}{2}a(14s)^2$
$a = .20 m/s^2$
$v_f = v_i + at$
$= (2 m/s^2)(14s) = 2.8 m/s$

69. An object in free fall can be described as

A) equilibrium
B) experiencing zero net force
C) experiencing a constant net force
D) experiencing a changing net force

$a = 9.81 m/s^2$ the entire time
acceleration means net force

70. A space craft traveling with an initial speed of 3.2×10^3m/s encounters a gravitational field that causes it to accelerate at 12 m/s^2 for 4 min. What is the final speed of the space craft?

A) 6.080×10^3 m/s B) 3.248×10^3 m/s
C) 2.880×10^3 m/s D) 4.8×10^1 m/s

$v = 3.2 \times 10^3$ m/s
$a = 12 m/s^2$
$t = 4 min = 240s$

$v_f = v_i + at$
$v_f = 3.2 \times 10^3 m/s + (12 m/s^2)(240s)$
$= 6080 m/s$
$= 6.08 \times 10^3 m/s$

71. A rocket is launched downward with an initial launch velocity of 40m/s and then pulled by the Earth's gravitational field. The launch occurs 750m above the Earth's surface. What is the magnitude of the rocket's final velocity?

A) 1.3×10^2 m/s B) 1.6×10^4 m/s
C) 1.2×10^2 m/s D) 6.7×10^1 m/s

$v_i = 40 m/s$
$a = 9.8 m/s^2$
$d = 750 m$
$v_f = ?$

$v_f^2 = v_i^2 + 2ad$
$v_f^2 = (40 m/s)^2 + 2(9.81 m/s^2)(750m)$
$v_f = 127.7 m/s$

or

Δ	v_i	v_f	$\bar{v}$	d	a	t
	0	2.8 m/s	1.4 m/s	20m		14s

72. Base your answer to the following question on the information below.

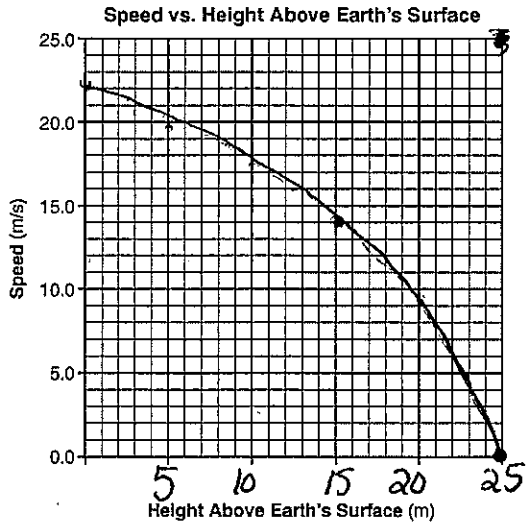
A 1.00-kilogram mass was dropped from rest from a height of 25.0 meters above Earth's surface. The speed of the mass was determined at 5.0-meter intervals and recorded in the data table below

Using the information in the data table, construct a graph on the grid below, following the directions below.

Data Table

Height Above Earth's Surface (m)	Speed (m/s)
25.0	0.0
20.0	9.9
15.0	14.0
10.0	17.1
5.0	19.8
0	22.1

Mark an appropriate scale on the axis labeled "Height Above Earth's Surface (m)." Create a "best curve" line based on plot.



73. Using your graph, determine the speed of the mass after it has fallen a vertical distance of 12.5 meters. How is the speed different from the velocity in this scenario? 16.5 m/s Velocity includes direction

74. As the distance of the fall doubles, what happens to the velocity of the object? [Hint think about the equation that relates final velocity and distance for a falling object]

$v_f = \sqrt{2ad}$

75. If the landing velocity when dropped from 25m is v_f, what would be the landing velocity in terms of v_f when dropped from 50m

$\sqrt{2}v_f$