Worksheet #5

Physics – Mr. Hall

PROJECTILES

Name: _____

1. A ball rolls off a table/cliff/falls out of a plane at a speed of 20.0 m/s from a height of 8.50 m. (a) How long before it hits the ground? (b) How fast does it hit in the vertical direction? (c) What is its total speed when it hits? (d) How far did it travel horizontally before it hit?

a) $d = d_i + v_i t + \frac{1}{2} a t^2$
$8.5\ m = 0\ m + (0\ m/s)\ t + \frac{1}{2} (9.8\ m/s^2)\ t^2$
$8.5\ m = (4.9\ m/s^2)\ t^2$
$t^2 = 8.50\ m / 4.9\ m/s^2 = 1.734693878\ s^2$
$t = 1.31707778\ s =$ **1.32 s**

b) $v = v_i + at$
$v = 0\ m/s + (9.8\ m/s^2)(1.31707778\ s) = 12.90736224\ m/s =$ **12.9 m/s**

OR

$v^2 = v_i^2 + 2ad$
$v^2 = (0\ m/s) + 2(9.8\ m/s^2)(8.50\ m) = 166.6\ m^2/s^2$
$v = 12.90736224\ m/s =$ **12.9 m/s**

c) $v_{total}^2 = v_{horiz}^2 + v_{vert}^2$
$v_{total}^2 = (20.0\ m/s)^2 + (12.90736224\ m/s)^2 = 566.6\ m^2/s^2$
$v_{total} = 23.803361107\ m/s =$ **23.8 m/s**

d) $d = d_i + v_i t + \frac{1}{2} a t^2$
$d = 0\ m + (20.0\ m/s)(1.31707778\ s) + \frac{1}{2} (0\ m/s^2)(1.31707778\ s)^2 = 26.34155559\ m =$ **26.3 m**

2. Joe/Fred/Penny/Abdul throws/launches/catapults/tosses a ball/rock/hedgehog/piano at an angle of 32.5° and an initial velocity of 25.8 m/s. (a) How long is it in the air? (b) How far up does it go before coming back down? (c) How fast is it going in the vertical direction when it hits? (d) What is its total speed when it hits? (e) How far from its starting point does it hit the ground?

$v_{horiz} = 25.8\ m/s \cos(32.5°) = 21.759499302\ m/s$
$v_{vert} = 25.8\ m/s \sin(32.5°) = 13.862329895\ m/s$

a) $v = v_i + at$
$0\ m/s = 13.862329895\ m/s + (-9.8\ m/s^2)\ t$
$-13.862329895\ m/s = (-9.8\ m/s^2)\ t$
$t = (-13.862329895\ m/s) / (-9.8\ m/s^2) = 1.4145234587\ s$ (time from launch to top of arc)
$t = 2 \cdot 1.4145234587\ s = 2.8290469174\ s =$ **2.83 s**

OR

$v = v_i + at$
$-13.862329895\ m/s = 13.862329895\ m/s + (-9.8\ m/s^2)\ t$
$-27.724659790\ m/s = (-9.8\ m/s^2)\ t$
$t = (-27.724659790\ m/s) / (-9.8\ m/s^2) = 2.8290469174\ s =$ **2.83 s**

b) $d = d_i + v_i t + \frac{1}{2} a t^2$
$d = 0\ m + (13.862329895\ m/s)(1.4145234587\ s) + \frac{1}{2} (-9.8\ m/s^2)(1.4145234587\ s)^2$
$d = 9.804295415\ m =$ **9.80 m**

OR

2. b) (...continued)

$v^2 = v_i^2 + 2ad$
$(0\ m/s)^2 = (13.862329895\ m/s)^2 + 2(-9.8\ m/s^2)d$
$(-192.16419013\ m^2/s^2) = (-19.6\ m/s^2)\ d$
$d = (-192.16419013\ m^2/s^2) / (-19.6\ m/s^2) = 9.804295415\ m =$ **9.80 m**

c) $v = v_i + a\ t$
$v = 13.862329895\ m/s + (-9.8\ m/s^2)(2.8290469174\ s) = -13.862329896\ m/s =$ **-13.9 m/s**

d) $v_{total}^2 = v_{horiz}^2 + v_{vert}^2$
$v_{total}^2 = (21.759499302\ m/s)^2 + (-13.862329896\ m/s)^2 = 665.640000\ m^2/s^2$
$v_{total} = 25.8000000\ m/s =$ **25.8 m/s**

e) $d = d_i + v_i t + \frac{1}{2}\ at^2$
$d = 0\ m + 21.759499302\ m/s \cdot 2.8290469174\ s = 61.5586444\ m =$ **61.6 m**

3. Joe/Fred/Penny/Abdul throws/launches/catapults/tosses a ball/rock/hedgehog/piano at an angle of 34.0° and an initial velocity of 18.5 m/s from the edge of a cliff/table that is 20.5 m above the ground. (a) How long is it in the air? (b) How high does it go at the highest point? (c) What is its final vertical speed as it hits the ground? (d) What is its total speed as it hits? (e) How far away did it land?

$v_{horiz} = v\cos(\theta) = (18.5\ m/s)\cos(34.0°) = 15.33719509\ m/s$
$v_{vert} = v\sin(\theta) = (18.5\ m/s)\sin(34.0°) = 10.345068714\ m/s$

a) $v = v_i + at_{(up)}$
$0\ m/s = 10.345068714\ m/s + (-9.8\ m/s^2)\ t_{(up)}$
$-10.345068714\ m/s = (-9.8\ m/s^2)\ t_{(up)}$
$t_{(up)} = (-10.345068714\ m/s) / (-9.8\ m/s^2) = 1.055619257\ s$

b) $d = d_i + v_i t + \frac{1}{2}\ at^2$
$d = 0\ m + (10.345068714\ m/s)(1.055619257\ s) + \frac{1}{2}\ (-9.8\ m/s^2)(1.055619257\ s)^2$
$d = 5.46022687\ m =$ **5.46 m**

OR

$v^2 = v_i^2 + 2ad$
$(0\ m/s)^2 = (10.345068714\ m/s)^2 + 2(-9.8\ m/s^2)\ d$
$-107.0204467\ m^2/s^2 = (-19.6\ m/s^2)\ d$
$d = (-107.0204467\ m^2/s^2) / (-19.6\ m/s^2) = 5.46022687\ m =$ **5.46 m**

a) $d = d_i + v_i t_{(down)} + \frac{1}{2}\ at_{(down)}^2$
$(20.5\ m + 5.46022687\ m) = 0\ m + (0\ m/s)\ t_{(down)} + \frac{1}{2}\ (9.8\ m/s^2)\ t_{(down)}^2$
$25.96022687\ m = (4.9\ m/s^2)\ t_{(down)}^2$
$t_{(down)}^2 = 25.96022687\ m / (4.9\ m/s^2) = 5.29800548\ s^2$
$t_{(down)} = 2.301739665\ s$
$t_{total} = t_{up} + t_{down} = 1.055619257\ s + 2.301739665\ s = 3.35735892172\ s =$ **3.36 s**

c) $v_{down} = v_i + at_{down}$
$v_{down} = 0\ m/s + (9.8\ m/s^2)(2.301739665\ s) = 22.557048717\ m/s =$ **22.6 m/s**

d) $v_{total}^2 = v_{down}^2 + v_{horiz}^2$
$v_{total}^2 = (22.557048717\ m/s)^2 + (15.33719509\ m/s)^2$

3. d) (continued...)

$v_{total}^2 = 744.0500000\ m^2/s^2$

$v_{total} = 27.2772799\ m/s =$ **27.3 m/s**

e) $d = d_i + v_i t + \frac{1}{2} a t^2$

$d = 0\ m + (15.33719509\ m/s)(3.35735892172\ s) + \frac{1}{2} (0\ m/s^2) (3.35735892172\ s)^2$

$d = 51.49246876957\ m =$ **51.5 m**