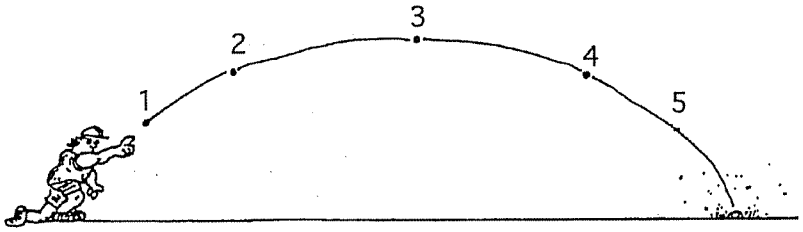
PHYSICS 12

NAME: Key

Kinematics and Projectiles Review



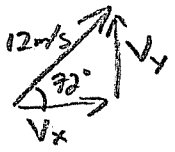
(1-3) A ball is thrown into the air, following the path shown in the diagram. At **1**, the ball has just left the thrower's hand. At **5**, the ball is at its original height above the ground. Assume negligible air friction when answering these questions:

1. The **acceleration** of the ball while it is in flight has magnitude '*g*' when the ball is at
   A. 1, 2, 3, 4 and 5.
   B. 1 only.
   C. 1 and 5 only.
   D. 1, 2, 4 and 5 only.

2. The **horizontal velocity** of the ball is at a maximum at
   A. 1, 2, 3, 4 and 5.
   B. 1 only.
   C. 3 only.
   D. 5 only.
   E. 1 and 5 only.

3. The magnitude of the **vertical velocity** of the ball is at a maximum at
   A. 1 only.
   B. 5 only.
   C. 1 and 5 only.
   D. 3.
   E. 1, 2, 3, 4, and 5.

4. A ball is tossed in a direction 72° above the horizontal, with a velocity of 12 m/s. What is the maximum height the ball will reach?
   A. 0.70 m
   B. 6.6 m
   C. 7.3 m
   D. 70 m



$V_x = 12\cos 72° = 3.7\ m/s$

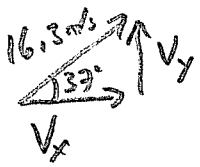
$V_y = 12\sin 72° = 11.4\ m/s$

$V_f^2 = V_0^2 + 2ad$

$0 = (11.4)^2 + 2(-9.8)d$

$d = 6.6\ m$

5. A projectile is launched with a velocity of 16.3 m/s, at an angle of 37° with the horizontal. How much time will elapse before the vertical component of the velocity is zero?
   A. 1.66 s
   B. 1.33 s
   C. 1.25 s
   D. 1.00 s



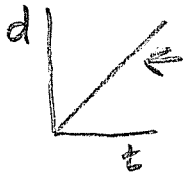
$V_y = 16.3\sin 37° = 9.8\ m/s$

$V_f = V_0 + at$

$0 = 9.8 + (-9.8)t$

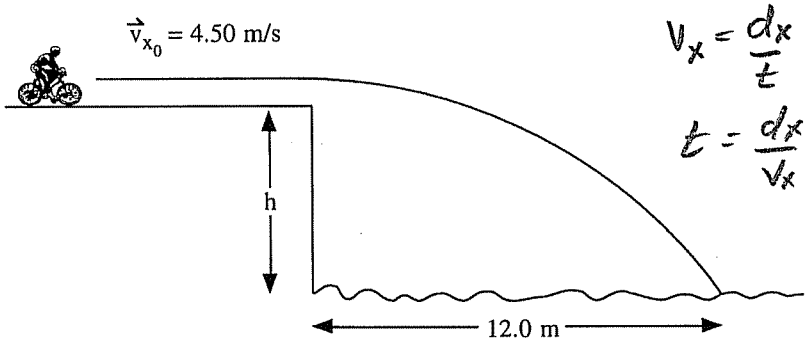
$t = 1\ s$

6. An observer records time (t), displacement (d) and velocity (v) of a skier sliding from rest down a ski slope, with uniform acceleration. He plots graphs using different variables. In which case will the observer **not** obtain a straight line?
   A. d vs t.
   B. d vs t^2.
   C. v vs t.
   D. v^2 vs d.



← constant velocity, does not happen

Open-Ended Questions



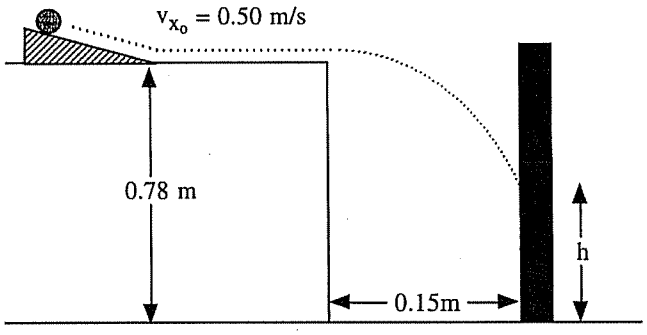
$v_x = \frac{d_x}{t}$

$t = \frac{d_x}{v_x} = \frac{12}{4.5} = 2.7s$

$d_y = v_0 t + \frac{1}{2} a t^2$

$= 0 + \frac{1}{2}(9.8)(2.7)^2$

7. A daredevil BMX rider runs his bike off a cliff with a horizontal velocity of 4.5 m/s, and lands in the water 12 m from the base of the cliff.
   (a) How long does it take the rider to hit the water? 2.7s
   (b) How high is the cliff? = 34.8 m



$t = \frac{d_x}{v_x} = \frac{.15}{.5} = .3s$

$d_y = v_0 t + \frac{1}{2} a t^2$

$= 0 + \frac{1}{2}(-9.8)(.3s)^2$

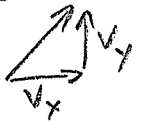
$= .441$

$h = .78 - .441 = .34m$

8. A marble is accelerated to a horizontal velocity of 0.50 m/s by rolling it down a small ramp. The marble rolls off the table, which is 0.78 m high. As it falls, it hits a barrier on the way down. If the barrier is 0.15 m from the edge of the table, at what height from the ground, h, will the marble hit the barrier?

9. As part of a NASA experiment, golfer Tiger Woods drives a golf ball on the moon, where $g = 1.60$ m/s^2. He 'launches' a golf ball with a speed of 285 km/h, at an angle of 42° with the horizontal. What horizontal distance will his drive travel before landing back on the surface of the moon. Ignore the curvature of the moon.

79.2m/s



$v_x = (79.2)\cos 42$

$= 58.9 m/s$

$v_y = 79.2 \sin 42$

$= 53 m/s$

$t = \frac{v_f - v_0}{a} = \frac{-53 - 53}{-9.8} = 10.8$

$dx = v_x \cdot t = (58.9)(10.8)$

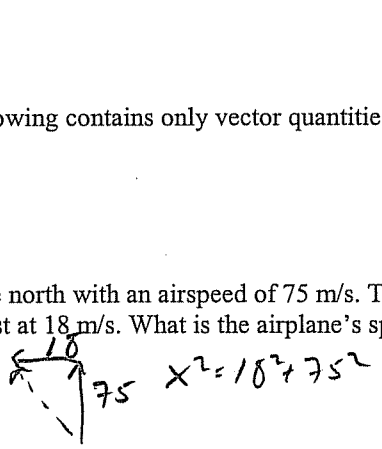
$= 637m$

10. A projectile is launched with a speed of 128 m/s, at an angle of 60° with the horizontal.
    (a) After 2.0 s, what is the vertical component of the projectile's velocity?
    (b) After 2.0 s, what is the speed of the projectile?

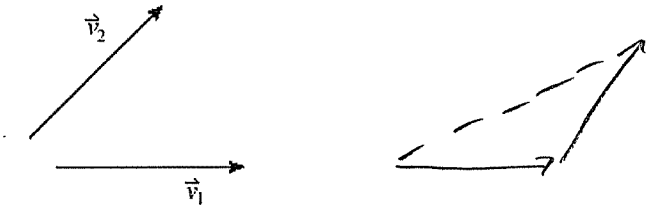
Assignment

1. Which one of the following contains only vector quantities?
A. mass, time
B. force, velocity
C. time, momentum
D. acceleration, speed

2. An airplane heads due north with an airspeed of 75 m/s. The wind is blowing due west at 18 m/s. What is the airplane's speed relative to the ground?
A. 57 m/s
B. 73 m/s
C. 77 m/s
D. 93 m/s



3. Two velocity vectors, v_1 and v_2 are shown.

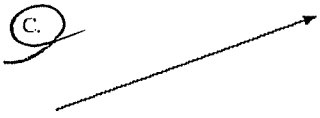


Which of the following best represents the resultant of the addition of the two velocity vectors?

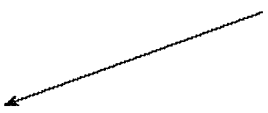
A.

B.

C.

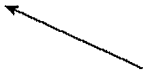


D.

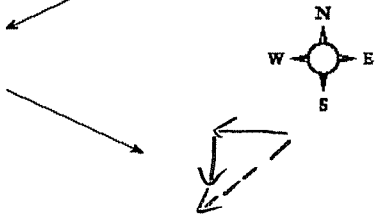


4. A car travelling north at 20 m/s is later travelling west at 30 m/s. What is the direction of the change in velocity?

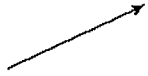
A.



B. $v_f - v_0 = v_{f+} - v_0$

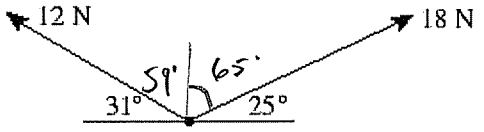


C.

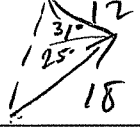


D.

5. Two forces act at a single point as shown.



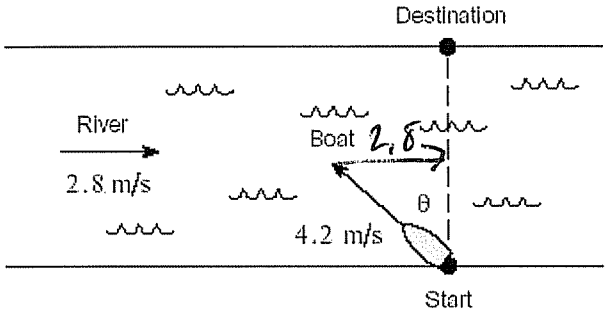
What is the magnitude of the resulting force?
A. 15 N
B. 22 N
C. 27 N



cos law

D. 30 N

6. A boat shown below travels at 4.2 m/s relative to the water, in a river flowing at 2.8 m/s.



At what angle θ must the boat head to reach the destination directly across the river?
A. 34°
B. 42°
C. 48°
D. 56°

$\sin^{-1}\left(\frac{2.8}{4.2}\right) = 42°$

7. In landing, a jet plane decelerates uniformly and comes to a stop in 38 s, covering a distance of 1500 m along the runway. What was the jet's landing speed when it first touched the runway?
A. 2.1 m/s
B. 39 m/s
C. 79 m/s
D. 170 m/s

opposite approach

$d = v_i t + \frac{1}{2} a t^2$
$1500 = 0 + \frac{1}{2} a (38)^2$
$a = 2.1 m/s^2$

$v_f^2 = v_0^2 + 2ad$
$= 0 + 2(2.1)(1500)$
$v_f = 79 m/s$

8. A 35 kg object released from rest near the surface of a planet falls 7.3 m in 1.5 s. What is the acceleration due to gravity on this planet?
A. 4.9 m/s²
B. 6.5 m/s²
C. 9.7 m/s²
D. 170 m/s²

$d = 7.3m$
$t = 1.5s$
$V_0 = 0$

$d = v_0 t + \frac{1}{2} a t^2$
$7.3m = 0 + \frac{1}{2}(a)(1.5)^2$
$a = 6.5 m/s^2$

9. A ball is thrown vertically upward at 20 m/s from a height of 30 m above the ground. What is its speed on impact with the ground below?
A. 14 m/s
B. 24 m/s
C. 31 m/s
D. 44 m/s

$d = -30m (\downarrow)$
$a = -9.8 m/s^2 (\downarrow)$
$V_0 = 20 m/s (\uparrow)$

$v_f^2 = v_0^2 + 2ad$
$= 20^2 + 2(-9.8)(-30)$

$V_f =$

10. Which of the following graphs best illustrates the horizontal displacement of a projectile as a function of time? Ignore friction. V_x = constant

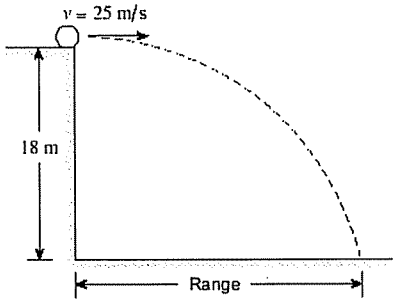
A. d_x vs t

B. d_x vs t

C. d_x vs t

D. d_x vs t

11. What is the range of the projectile launched horizontally at 25 m/s from the 18 m-high cliff edge as shown in the diagram below?



$d = v_0 t + \frac{1}{2} a t^2$

$18m = 0 + \frac{1}{2}(9.8)t^2$

$t = 1.9s$

$d_x = V_x \cdot t$

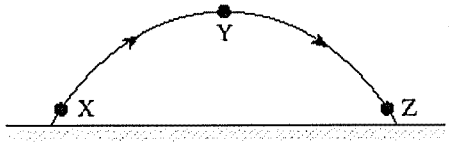
$= (25)(1.9)$

$= 47.5m$

A. 18 m
B. 30 m
C. 46 m
D. 48 m

12. Consider three points in the path of a certain projectile as shown in the diagram below.

always 9.8 ↓



What is the acceleration of the projectile at each of these points?

	ACCELERATION (m/s^2)		
	At X	At Y	At Z
A.	+9.8	0	−9.8
B.	+9.8	0	+9.8
C.	−9.8	0	−9.8
D.	−9.8	−9.8	−9.8

13. Which of the following is true for projectile motion? (Ignore friction.)

	HORIZONTAL COMPONENT	VERTICAL COMPONENT
A.	constant velocity	constant velocity
B.	constant velocity	changing velocity
C.	changing velocity	constant velocity
D.	changing velocity	changing velocity

14. An object is launched over level ground at 35° above the horizontal with an initial speed of 52 m/s. What is the time of flight?

A. 5.3 s
B. 6.1 s
C. 8.7 s
D. 11 s

52, 35°, V_y, V_x

$V_y = 52 \sin 35°$

$= 29.8$

$V_f = V_0 + at$

$-29.8 = 29.8 + at$

$t = \frac{59.6}{9.8} = 6.1$

15. A projectile is fired with an initial velocity of 65 m/s at an angle of 23° above the horizontal. If air resistance is negligible, how much time elapses before the projectile reaches its maximum height?

A. 2.6 s
B. 2.8 s
C. 6.1 s
D. 6.6 s

$V_f = V_0 + at$

65, 23°

$V_y = 65 \sin 23°$

$= 25.4 m/s$

$0 = 25.4 + (-9.8)t$

$t = 2.6s$

16. A projectile is launched at 35.0° above the horizontal with an initial velocity of 120 m/s.
What is the projectile's speed 3.00 s later?

A. 68.8 m/s
B. 98.3 m/s
C. 106 m/s
D. 120 m/s

$V_f = V_0 + at$

120, 35°

$V_x = 98.3$

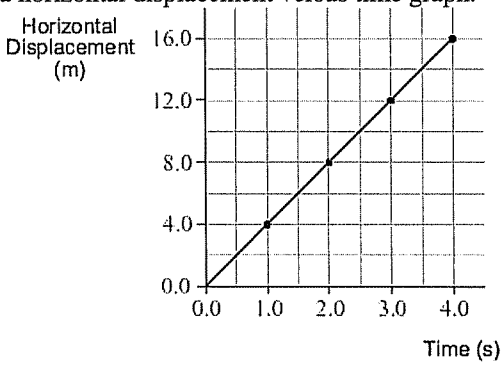
$V_y = 68.8$

$V_{y_f} = 68.8 + (-9.8)(3)$

$= 39.4 m/s$

106, 39.4

17. A projectile is fired into the air at some angle above the horizontal. The horizontal displacement of the projectile is measured against time in flight and the collected data is shown as a horizontal displacement versus time graph.



d vs t

slope = V_f

constant

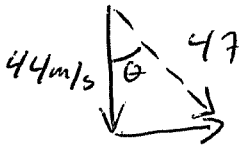
Based on this graph, the horizontal velocity of the projectile during this time interval is

A. constant.
B. increasing.
C. decreasing.
D. equal to zero

18. An aircraft heads due south with a speed relative to the air of 44 m/s. Its resultant speed over the ground is 47 m/s. The wind blows from the west.

east

a) What is the speed of the wind?



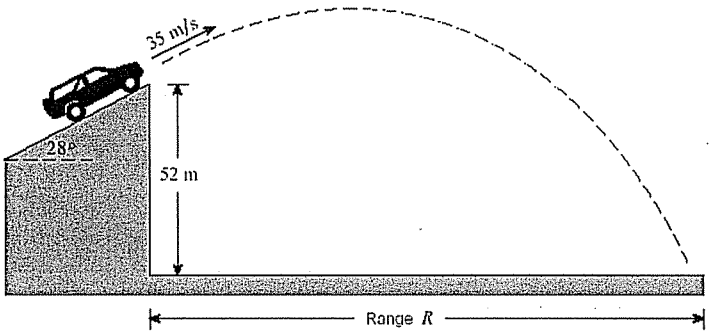
$47^2 - 44^2 = c^2$

$c = 16.5 \text{ m/s}$

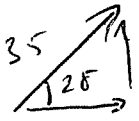
b) What is the direction of the aircraft's path over the ground?

$\cos^{-1}\left(\frac{44}{47}\right) = 26^\circ$ [E of S]

19. A stunt vehicle leaves an incline with a speed of 35 m/s at an angle of 28° at a height of 52 m above level ground. Air resistance is negligible.



a) What are the vehicle's vertical and horizontal velocity components as it leaves the incline?



$V_x = 35\cos 28^\circ$

$= 16.4$ ~~m/s~~

$V_y = 35 \sin 28^\circ = 16.4$

b) What is the vehicle's time of flight?

$V_x = 30.9 \text{ m/s}$

$d = v_0 t + \frac{1}{2} a t^2$

$\rightarrow -52 = 16.4t - \frac{1}{2}(9.8)t^2$

$4.9t^2 - 16.4t - 52 \quad t = 5.34 \text{ s}$

Quad Formula

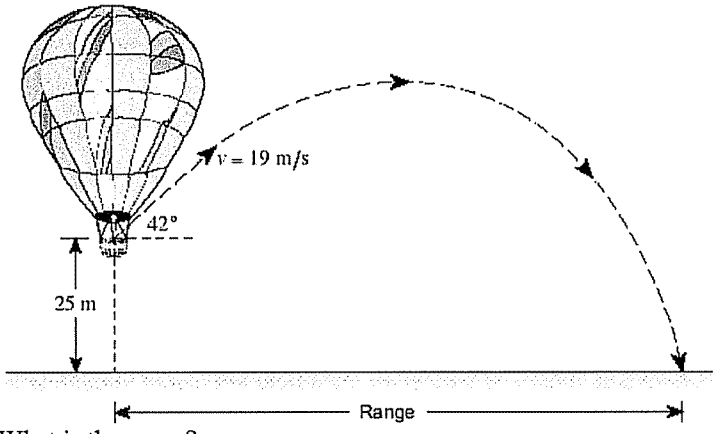
c) What is the vehicle's range, R ?

$d_x = v_x \cdot t$

$= (30.9)(5.34)$

$= 165 \text{ m}$

20. A 0.50 kg ball is thrown at 42° above the horizontal at 19 m/s from a stationary hot air balloon 25 m above the ground.



What is the range?

$19 \sin 42° = 12.7 \text{ m/s}$

$19 \cos 42° = 14.1 \text{ m/s}$

$v_f^2 = v_0^2 + 2ad$

$= (12.7 \text{ m/s})^2 + 2(-9.8)(-25)$

$v_f = 25.5 \text{ m/s} \downarrow$

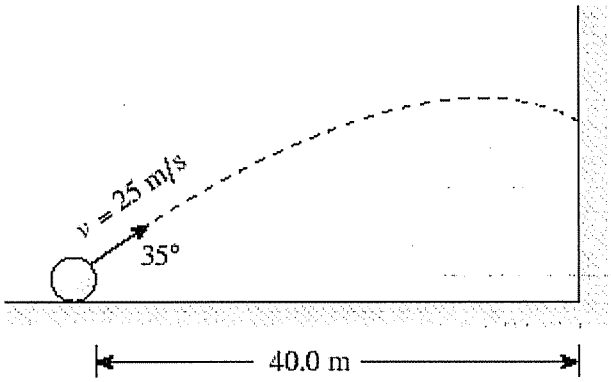
$v_f = v_0 + at \quad t = \frac{v_f - v_0}{a} = \frac{-25.5 - 12.7}{-9.8 \text{ m/s}^2}$

$t = 3.89 \text{ s}$

$d_x = v_x \cdot t = (14.1)(3.89)$

$= 55 \text{ m}$

21. A projectile is launched towards a wall as shown in the diagram below.



With what velocity (magnitude and direction) does the projectile hit the wall?

$25 \sin 35 = 14.3 \text{ m/s}$

$25 \cos 35 = 20.5 \text{ m/s}$

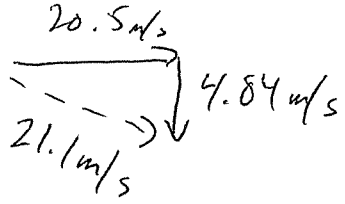
$v_y = v_0 + at$

$= 14.3 + (-9.8)(1.9 \text{ s})$

$= -4.84 \text{ (down)}$

$d_x = v_x \cdot t$

$40 = 20.5(t) \quad t = 1.95 \text{ s}$



$\theta = \tan^{-1}\left(\frac{4.84}{20.5}\right) = 13.3°$

Answers: 1) B, 2) C, 3) C, 4) 5) A, 6) B, 7) C, 8) B, 9) C, 10) D, 11) D, 12) D, 13) B, 14) B, 15) A, 16) C, 17) A, 18a) 16.5 m/s, 18b) 20.6° [E of S], 19a) V_x=30.9 m/s, V_y = 16.4 m/s, 19b) 5.34 s, 19c) 164.9m, 20) 55m, 21) 21.06 m/s, 13.3° below the horizontal