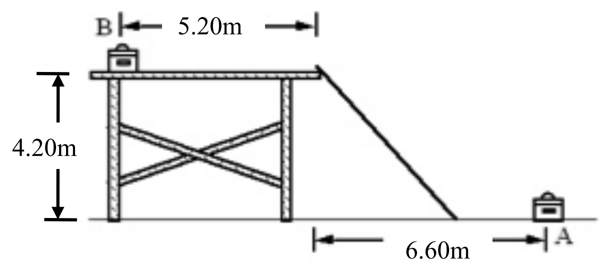
Exam 1 PHY231 Spring 2014 Sections 1&2

Form B



1. A toolbox sits at point A. It is then moved to the left, up the ramp and over to point B on a scaffold 4.20 high. What is the magnitude of its displacement in the movement from point A to point B?

A) 15.3 m
B) 18.10 m
C) 13.0 m
D) 17.0 m
E) 19.7 m
F) 11.6 m
G) 12.5 m
H) none of the choices is correct

$\Delta x = 6.00\,\text{m} + 5.20\,\text{m} = 11.2\,\text{m}; \quad \Delta y = 4.20\,\text{m}$

$\Delta\vec{\mathbf{d}} = (11.2\,\text{m})\hat{\mathbf{i}} + (4.20\,\text{m})\hat{\mathbf{j}}; \quad |\Delta\vec{\mathbf{d}}| = \sqrt{(\Delta x)^2 + (\Delta y)^2} = \underline{12.5\,\text{m}}$

2. An eagle is flying due east at 8.90 m/s carrying a gopher in its talons. The gopher manages to break free at a height of 20.0 m. What is the magnitude of the gopher's velocity as it reaches the ground? Note: effects of air resistance are not included in this calculation.

A) 22.7 m/s
B) 17.7 m/s
C) 21.7 m/s
D) 9.87 m/s
E) 8.97 m/s
F) 16.7 m/s
G) 12.7 m/s
H) 19.7 m/s

$v_x = 8.90 \text{ m/s}, \quad v_{y0} = 0$

$v_y^2 = v_{y0}^2 + 2a\Delta y = 2a\Delta y$

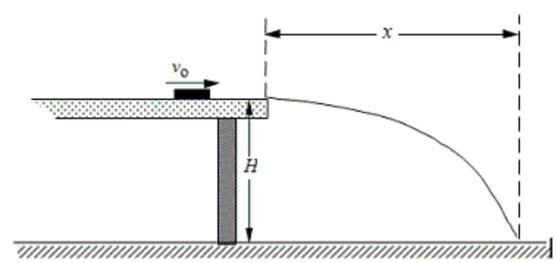
$v = \sqrt{2(-9.81\text{m/s}^2)(-20.0\,\text{m}) + (8.90\text{m/s})^2} = \underline{21.7\,\text{m/s}}$

3. A football is kicked at an angle of 37.3° with respect to the horizontal. Which one of the following statements best describes the kinematics of the football during this event if air resistance is neglected?

A) The acceleration is 9.81 m/s^2 before the football leaves the players foot.
B) The acceleration is zero m/s^2 during the entire free flight
C) The acceleration is 9.81 m/s^2 during the entire free flight
D) The acceleration is zero m/s^2 when the football reaches the highest point in its trajectory.
E) The velocity of the football remains constant during the entire flight
F) The velocity is higher at the beginning of the flight than it is at the end of the flight.
G) The acceleration starts at 9.8 m/s^2 and drops to a lower value just above the ground.
H) The acceleration is greater than 9.81 m/s^2 if the football is spinning rapidly.

No direction specified as positive $\rightarrow$ magnitudes only

4. A puck slides across a smooth, level tabletop at height H at a constant speed v_0. It slides off the edge of the table and hits the floor a distance x away as shown in the figure.



What equation relates the distance x to the given: H and v_0 and g?

A) $x = v_0^2\sqrt{\dfrac{H}{2g}}$
B) $x = \dfrac{v_0^2}{2gH}$
C) $x = \dfrac{v_0^2}{gH}$
D) $x = \dfrac{2H}{gv_0^2}$
E) $x = g\sqrt{\dfrac{v_0^2}{2H}}$
F) $x = v_0\sqrt{\dfrac{2H}{g}}$
G) $x = \dfrac{gH}{v_0^2}$
H) $x = v_0\sqrt{\dfrac{gH}{v_0^2}}$

find t from vertical motion, $v_{y0} = 0; \Delta x = x$

$\Delta y = v_{y0}t + \frac{1}{2}at^2 \rightarrow t = \sqrt{\dfrac{2\Delta y}{a}} = \sqrt{\dfrac{2H}{g}}$

$v_x = v_{x0} = v_0; \quad x = v_0 t = \underline{v_0\sqrt{\dfrac{2H}{g}}}$

5. A car is moving at a constant velocity when it is involved in a collision. The car comes to rest after 0.450 s with an average acceleration of 160.0 m/s^2 in the direction opposite that of the car's velocity. What was the speed of the car before the collision?

A) 27.0 m/s
B) 44.8 m/s
C) 97.2 m/s
D) 105 m/s
E) 144 m/s
F) 205 m/s
G) 72.0 m/s
H) 133 m/s

$v = 0,\ t = 0.450\text{s},\ a = 160\text{ m/s},\quad v_0 = ?$

$v = v_0 + at$

$v_0 = v - at = -(160\text{ m/s})(0.450\text{ s}) = -72\text{ m/s}$

speed = 72 m/s

6. A car starts from rest and accelerates at a constant rate in a straight line. In the first second the car moves a distance of 4.0 meters. How fast will the car be moving at the end of the second second?

A) 4.0 m/s
B) 16 m/s
C) 2.0 m/s
D) 32 m/s
E) 8.0 m/s
F) 0.25 m/s
G) 1.0 m/s
H) 0.5 m/s

$v_0 = 0,\quad \Delta x = 4.0\text{m},\quad t = 1\text{s}$

$\Delta x = v_0 t + \frac{1}{2}at^2 \quad \rightarrow \quad a = \frac{2\Delta x}{t^2} = \frac{2(4.0\text{m})}{(1\text{s})^2} = 8.0\text{m/s}^2$

Find v at $t = 2\text{s}$: $\quad v = v_0 + at = (8.0\text{m/s}^2)(2\text{s}) = 16\text{m/s}$

7. The minimum takeoff speed for a certain airplane is 75.0 m/s. If the plane starts from rest at one end of the runway what minimum acceleration is required if the plane must leave a runway of length 3150 m?

A) 0.50 m/s^2
B) 1.03 m/s^2
C) 1.51 m/s^2
D) 2.01 m/s^2
E) 0.89 m/s^2
F) 1.19 m/s^2
G) 1.79 m/s^2
H) 2.28 m/s^2

$v_0 = 0,\ v = 75\text{m/s},\ \Delta x = 3150\text{m}$

$v^2 = v_0^2 + 2a\Delta x$

$a = \frac{v^2}{2\Delta x} = \frac{(75\text{m/s})^2}{2(3150\text{m})} = 0.892\text{ m/s}^2$

8. A brick is dropped from rest from a height of 5.9 m. Assuming no air resistance, how long does it take for the brick to reach 1.0 m from the ground? (Hint: what is Δx ?)

A) 0.623 s
B) 1.00 s
C) 1.24 s
D) 1.47 s
E) 2.00 s
F) 0.892 s
G) 0.555 s
H) 4.90 s

$v_0 = 0,\ \Delta x = (1.0 - 5.9)\text{m};\ a = -9.81\text{m/s}^2$

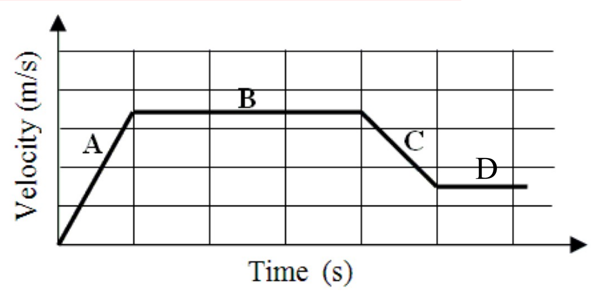
$\Delta x = v_0 t + \frac{1}{2}at^2$

$t^2 = \frac{2\Delta x}{a} = \frac{2(-4.9\text{m})}{-9.81\text{m/s}^2} = 1.00\text{s}^2;\ t = 1.00\text{s}$

9. Consider the plot of position vs. time shown on the right. The start of "A" is at (t = 0, v = 0).

What is (are) the region(s) where the acceleration is negative and constant throughout?

A) A
B) B
C) C
D) D
E) A and B
F) B and C
G) B and D
H) none of these choices



C) Negative slope throughout

10. A ball is thrown upward. At the highest point which statements are correct.

A) The ball is not moving.
B) The ball is stationary.
C) The ball is at rest.
D) A,B and C are all correct.
E) The ball is moving but with $a = 0$ but $v \neq 0$.
F) The ball is moving but with $a \neq 0$ but $v = 0$.
G) The ball is moving but with $a = 0$ and $v = 0$.
H) none of the other choices are correct

11. The speed of light is 3.00×10^8 m/s . What is the distance that light travels in 4 weeks?

A) 4.33×10^{12} m
B) 3.36×10^{13} m
C) 5.24×10^{14} m
D) 4.57×10^{15} m
E) 2.88×10^{11} m
F) 2.26×10^{12} m
G) 3.74×10^{13} m
H) 7.26×10^{14} m

$$4\text{weeks} = 28\text{days} = 28\text{days}\left(24\text{hrs/day}\right)(3600\text{s/hr}) = 2.43\times10^6\text{s}$$
$$\Delta x = vt = (3.00\times10^8\text{m/s})(2.43\times10^6\text{s}) = \underline{7.26\times10^{14}\text{m}}$$

12. The speed of light is 3.00×10^8 m/s, and the distance from the center to the surface of the Earth is 6.37×10^3 km. If light could curve, exactly 7 trips around the earth could be made in what time?

A) 20.2 microseconds
B) 2.67 seconds
C) 0.933 seconds
D) 1.30 milliseconds
E) 3.03 seconds
F) 8.33 milliseconds
G) 45.3 seconds
H) no time at all

$$\Delta x = 7(2\pi r) = 14\pi(6.37\times10^6\text{m}) = 2.80\times10^8\text{m}$$
$$t = \Delta x / v = (2.80\times10^8\text{m})/(3.00\times10^8\text{m/s}) = \underline{0.933\text{s}}$$

13. Which one of the following is equal to 8.0×10^7 cm^3?

A) 8.0×10^{-10} m^3
B) 8.0×10^{-9} m^3
C) 8.0×10^{-3} m^3
D) 8.0×10^1 m^3
E) 8.0×10^3 m^3
F) 8.0×10^6 m^3
G) 8.0×10^9 m^3
H) the correct answer is not given

$$(8.0\times10^7\text{cm}^3)(1\text{m}/100\text{cm})^3 = \underline{8.0\times10^1\text{m}^3}$$

14. The length of three sticks are 0.62 m, 0.78 m and 1.00 m, and are arranged to form a right triangle. What are the three angles of the triangle?

A) 90°, 45°, and 45°
B) 90°, 63°, and 38°
C) 90°, 59°, and 31°
D) 90°, 48°, and 42°
E) 90°, 52°, and 38°
F) 90°, 50°, and 40°
G) 90°, 65°, and 15°
H) 90°, 42°, and 38°

$$\theta_1 = 90°,\quad \tan\theta_2 = \frac{0.62}{0.78} \rightarrow \theta_2 = \tan^{-1}(0.795) = 38°$$
$$\theta_3 = 90° - 38° = 52° \quad \theta_1,\theta_2,\theta_3 = \underline{90°,38°,52°}$$

15. A force vector $\vec{\mathbf{F}}_1 = a\hat{\mathbf{i}} + b\hat{\mathbf{j}}$ and a second force vector $\vec{\mathbf{F}}_2 = c\hat{\mathbf{i}}$ both act on an object. A third force vector $\vec{\mathbf{F}}_3$ must act on the object if the sum of the three forces is zero. What is $\vec{\mathbf{F}}_3$?

A) $-(a+b+c)(\hat{\mathbf{i}}+\hat{\mathbf{j}})$
B) $-\sqrt{a^2+c^2}\hat{\mathbf{i}} - b\hat{\mathbf{j}}$
C) $(a-c)\hat{\mathbf{i}} + b\hat{\mathbf{j}}$
D) $(a+c)\hat{\mathbf{i}} + b\hat{\mathbf{j}}$
E) $(a+b+c)(\hat{\mathbf{i}}+\hat{\mathbf{j}})$
F) $-(a+c)\hat{\mathbf{i}} - b\hat{\mathbf{j}}$
G) $-\sqrt{(a^2-b^2+c^2)}(\hat{\mathbf{i}}+\hat{\mathbf{j}})$
H) $\sqrt{(a^2+b^2+c^2)}(\hat{\mathbf{i}}+\hat{\mathbf{j}})$

$$\vec{\mathbf{F}}_1 + \vec{\mathbf{F}}_2 + \vec{\mathbf{F}}_3 = 0 = \left(a\hat{\mathbf{i}} + b\hat{\mathbf{j}}\right) + c\hat{\mathbf{i}} + \vec{\mathbf{F}}_3$$
$$\vec{\mathbf{F}}_3 = \underline{-(a+c)\hat{\mathbf{i}} - b\hat{\mathbf{j}}}$$

16. In which of the following situations does the car have an eastward acceleration?

A) When a child throws a rock eastward from the car traveling westward.
B) The car travels eastward and slows down.
C) The car travels westward and speeds up.
D) The car travels westward and slows down.
E) The car starts from rest and then moves toward the west.
F) The car starts moving eastward but later is moving westward.
G) The car travels eastward at constant speed.
H) The car has an eastward acceleration in all of the cases above

$\Delta v = v - v_0$ where $v_0 > v$, v westward is +
Δv is negative, points eastward
$a = \Delta v / t$ points eastward