Closed book and closed notes. No work needs to be shown. Air resistance should be ignored for all problems.

1. Mark and David are at the origin of a coordinate system. Mark moves 5 meters East and 2 meters South. David moves 1 meter East and 3 meters North. Where is David in relation to Mark?

a. 5 m away, at 37^o West of North
b. 5 m away, at 53^o West of North
c. 9 m away, at 45^o West of North
d. 6.4 m away, at 51^o West of North
e. 6.4 m away, at 39^o West of North

2. The frequency (f) of a pendulum (the number of times it swings per second) is given by a well known formula that includes the acceleration due to gravity (g) and the length of the pendulum (ℓ). Use dimensional analysis to find the valid equation:

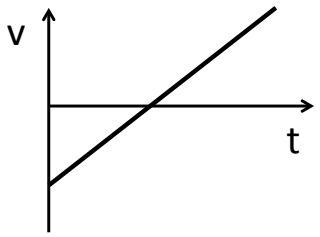
a. $f = \frac{1}{2\pi}\sqrt{\frac{\ell}{g}}$
b. $f = \frac{1}{2\pi}\sqrt{\frac{g}{\ell}}$
c. $f = \frac{1}{2\pi}\frac{g}{\ell}$
d. $f = \frac{1}{2\pi}\frac{\ell}{g}$
e. $f = \frac{1}{2\pi}\left(\frac{\ell}{g}\right)^2$

3. How many liters are there in a cubic yard? Conversion factors are on the equation sheet.

a. 0.0914 L
b. 91.4 L
c. 764 L
d. 2.85 L
e. 351 L

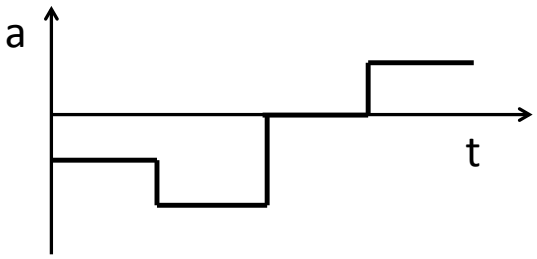
4. Dropping an object from a height h_0, it takes T seconds to reach the ground. How long would it take to reach the ground from double that height?

a. $T/2$ seconds
b. T seconds
c. $\sqrt{2}T$ seconds
d. $2T$ seconds
e. none of the above



5. What is the description of motion that corresponds the the graph above?

a. slow down and then speed up
b. speed up and then slow down
c. constantly slowing down
d. constantly speeding up
e. constant speed



6. For the object whose motion corresponds to the graph above, how many times does it turn around?

a. Never
b. Once
c. Twice
d. Three times
e. There is no way to know

7. An object is shot vertically upward with a velocity of 10 m/s. While it is rising:

a. its velocity and acceleration are both upward.
b. its velocity is upward and its acceleration is downward.
c. its velocity and acceleration are both downward.
d. its velocity is downward and its acceleration is upward.
e. its velocity is upward and its acceleration are both decreasing.

8. Two cars are 150 km apart and traveling towards each other. One is driving at a constant speed of 60.0 km/hr and the other is moving 40.0 km/hr. In how many hours will they meet?[*Hint: you don't know either of the cars' displacements, but you know that the two displacements have to add to 150 km.*]

a. 2.50 hours
b. 2.00 hours
c. 1.75 hours
d. 1.50 hours
e. 1.25 hours

9. An object travels westward with an initial velocity of 10 m/s and accelerates in the eastward direction with 50 m/s^2. How long will it take to come to a stop?

a. 0.1 s
b. 0.2 s
c. 0.5 s
d. 1.0 s
e. 5.0 s

10. Sheila throws a rock vertically downward with a speed of 14.0 m/s from the top of a 30.0 m tower. What is the rock's speed just as it hits the ground?

a. 12.0 m/s
b. 19.8 m/s
c. 28.0 m/s
d. 392 m/s
e. 784 m/s

11. Two balls, identical except for color, are projected horizontally from the roof of a tall building at the same instant. The initial speed of the red ball is twice the initial speed of the blue ball. Ignoring air resistance:

a. the red ball reaches the ground first.
b. the blue ball reaches the ground first.
c. both balls land at the same instant with the same speed.
d. both balls land at the same instant but the blue ball has more speed.
e. both balls land at the same instant but the red ball has more speed.

12. A ball thrown at an initial angle of 37^o from the horizontal with an initial velocity of 23 m/s reaches a maximum height h. With what initial speed must a ball be thrown *straight up* to reach the same maximum height h?

a. 13.8 m/s
b. 18.4 m/s
c. 23.0 m/s
d. 28.8 m/s
e. 38.2 m/s

13. A bullet is fired horizontally from a handgun at a target 20.0 m away. If the initial speed of the bullet as it leaves the gun is 100 m/s, how far vertically will the bullet have dropped by the time it hits the target?

a. 0.0980 m.
b. 0.196 m.
c. 0.392 m.
d. 0.294 m.
e. 0.490 m.

14. A cheetah can run at approximately 120 km/hr and a gazelle at 96.0 km/hr. If both animals are running at full speed, with the gazelle initially 84.0 m ahead, how long before the cheetah catches its prey?

a. 12.6 seconds.
b. 25.2 seconds.
c. 6.30 seconds.
d. 3.50 seconds.
e. 42.0 seconds.

15. The acceleration due to gravity on Jupiter is 2.5 times what it is on earth. An astronaut is in a centrifuge with radius 10.0 m. How fast does the centrifuge need to spin to simulate gravity on Jupiter?

a. 1.56 m/s
b. 2.45 m/s
c. 245 m/s
d. 15.6 m/s
e. We can't solve this without knowing the mass of the astronaut.

Equations and Constants

$$\left\{\begin{array}{l} x = r\cos\theta \\ y = r\sin\theta \end{array}\right\}; \qquad \left\{\begin{array}{l} r = \sqrt{x^2+y^2} \\ \theta = \tan^{-1}\left(\frac{y}{x}\right) \end{array}\right\};$$

$$\left\{\begin{array}{c} v_x = v_{0x} + a_y t \\ \Delta x = \frac{1}{2}(v_{0x}+v_x)t \\ \Delta x = v_{0x}t + \frac{1}{2}a_x t^2 \\ v_x^2 = v_{0x}^2 + 2a_x\Delta x \end{array}\right\}; \qquad \left\{\begin{array}{c} v_y = v_{0y} + a_x t \\ \Delta y = \frac{1}{2}(v_{0y}+v_y)t \\ \Delta y = v_{0y}t + \frac{1}{2}a_y t^2 \\ v_y^2 = v_{0y}^2 + 2a_y\Delta y \end{array}\right\};$$

$$\left\{\begin{array}{l} \Delta x = x_f - x_i \\ speed_{ave} = \frac{d}{\Delta t} \end{array}\right\}; \qquad \left\{\begin{array}{l} v_{ave} = \frac{\Delta x}{\Delta t} \\ a_{ave} = \frac{\Delta v}{\Delta t} \end{array}\right\}; \qquad \left\{\begin{array}{l} v = \lim_{\Delta t\to 0}\frac{\Delta x}{\Delta t} \\ a = \lim_{\Delta t\to 0}\frac{\Delta v}{\Delta t} \end{array}\right\};$$

$$\left\{\begin{array}{l} a_c = \frac{v^2}{r} \\ T = \frac{2\pi r}{v} \end{array}\right\}; \qquad x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A};$$

$$g = 9.80 \text{ m/s}^2$$

$$\left\{\begin{array}{c} 60 \text{ s} = 1 \text{ min} \\ 60 \text{ min} = 1 \text{ hr} \end{array}\right\}; \qquad \left\{\begin{array}{c} 1 \text{ cm}^3 = 1 \text{ mL} \\ 2.54 \text{ cm} = 1 \text{ inch} \\ 12 \text{ inches} = 1 \text{ ft} \\ 3 \text{ ft} = 1 \text{ yrd} \end{array}\right\}$$