

Tutorial Midterm
May 19, 2018

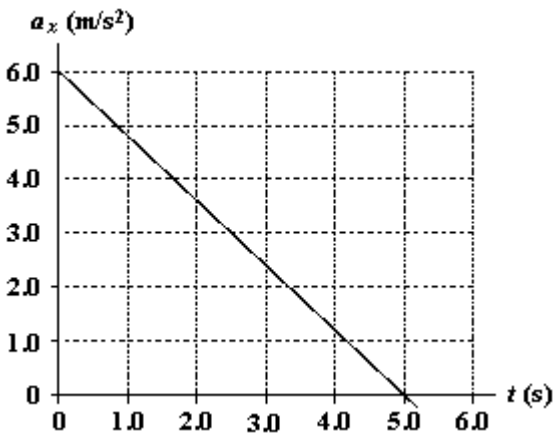
Multiple Choice

Identify the choice that best completes the statement or answers the question. Duration of the exam: 90 minutes

1. Which of the following products of ratios gives the conversion factors to convert meters per second $\left(\frac{\text{m}}{\text{s}}\right)$ to miles per hour $\left(\frac{\text{mi}}{\text{h}}\right)$?

- a. $\frac{5\,280\text{ f}}{\text{mi}} \cdot \frac{12\text{ in}}{\text{f}} \cdot \frac{2.54\text{ cm}}{1\text{ in}} \cdot \frac{100\text{ cm}}{1\text{ m}} \cdot \frac{3\,600\text{ s}}{1\text{ h}}$
 b. $\frac{5\,280\text{ f}}{\text{mi}} \cdot \frac{12\text{ in}}{\text{f}} \cdot \frac{1\text{ in}}{2.54\text{ cm}} \cdot \frac{1\text{ m}}{100\text{ cm}} \cdot \frac{1\text{ h}}{3\,600\text{ s}}$
 c. $\frac{5\,280\text{ f}}{\text{mi}} \cdot \frac{12\text{ in}}{\text{f}} \cdot \frac{2.54\text{ cm}}{1\text{ in}} \cdot \frac{100\text{ cm}}{1\text{ m}} \cdot \frac{1\text{ h}}{3\,600\text{ s}}$
 d. $\frac{1\text{ mi}}{5\,280\text{ f}} \cdot \frac{1\text{ f}}{12\text{ in}} \cdot \frac{1\text{ in}}{2.54\text{ cm}} \cdot \frac{100\text{ cm}}{1\text{ m}} \cdot \frac{3\,600\text{ s}}{1\text{ h}}$
 e. $\frac{1\text{ mi}}{5\,280\text{ f}} \cdot \frac{1\text{ f}}{12\text{ in}} \cdot \frac{1\text{ in}}{2.54\text{ cm}} \cdot \frac{1\text{ m}}{100\text{ cm}} \cdot \frac{3\,600\text{ s}}{1\text{ h}}$

2. At $t = 0$, a particle is located at $x = 25\text{ m}$ and has a velocity of 15 m/s in the positive x direction. The acceleration of the particle varies with time as shown in the diagram. What is the velocity of the particle at $t = 5.0\text{ s}$?

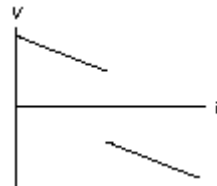


- a. $+15\text{ m/s}$
 b. -15 m/s
 c. $+30\text{ m/s}$
 d. 0
 e. -1.2 m/s

3. An object is thrown vertically upward such that it has a speed of 25 m/s when it reaches two thirds of its maximum height above the launch point. Determine this maximum height.

- a. 64 m
 b. 48 m
 c. 32 m
 d. 96 m
 e. 75 m

4. The graph below shows the velocity versus time graph for a ball. Which explanation best fits the motion of the ball as shown by the graph?



- a. The ball is falling, is caught, and is thrown down with greater velocity.
 b. The ball is rolling, stops, and then continues rolling.
 c. The ball is rising, hits the ceiling, and falls down.
 d. The ball is falling, hits the floor, and bounces up.
 e. The ball is rising, is caught, and then is thrown down.
5. A particle is moving at constant velocity. Its position at $t = 1.0\text{ s}$ is 3.0 m and its position at $t = 4.0\text{ s}$ is 15.0 m . What is the slope of the position-time graph for this particle?
- a. 0 , since this is a constant velocity situation.
 b. 4.0 m/s
 c. 4.0 m/s^2
 d. 9.0 m/s
 e. 12 m/s^2

Instructions: On occasion, the notation $\vec{A} = [A, \theta]$ will be a shorthand notation for $\vec{A} = A \cos \hat{e}_1 + A \sin \hat{e}_2$.

6. If $\vec{C} = [2.5 \text{ cm}, 80^\circ]$, i.e., the magnitude and direction of \vec{C} are 2.5 cm and 80° , $\vec{D} = [3.5 \text{ cm}, 120^\circ]$, and $\vec{E} = \vec{D} - 2\vec{C}$, what is the direction of \vec{E} (to the nearest degree)?

- 247°
- 235°
- 243°
- 216°
- 144°

7. Which statement is true about the unit vectors \hat{i} , \hat{j} and \hat{k} ?

- Their directions are defined by a left-handed coordinate system.
- The angle between any two is 90 degrees.
- Each has a length of 1 m.
- If \hat{i} is directed east and \hat{j} is directed south, \hat{k} points up out of the surface.
- All of the above.

Instructions: On occasion, the notation $\vec{A} = [A, \theta]$ will be a shorthand notation for $\vec{A} = A \cos \hat{e}_1 + A \sin \hat{e}_2$.

8. Given the statement that $\vec{A} - \vec{B} = -\vec{A} + \vec{C}$, what can we conclude?
- $\vec{C} = \vec{A}$ and $\vec{B} = \vec{A}$.
 - $2\vec{A} = \vec{B} + \vec{C}$.
 - $\vec{C} = -\vec{B}$ and $-\vec{A} = \vec{A}$.
 - Any one of the answers above is correct.
 - Only (a) and (b) may be correct.

9. The only force acting on a 2.0-kg body moving along the x axis is given by $F_x = (2.0x) \text{ N}$, where x is in m. If the velocity of the object at $x = 0$ is +3.0 m/s, how fast is it moving at $x = 2.0 \text{ m}$?

- 4.2 m/s
- 3.6 m/s
- 5.0 m/s
- 5.8 m/s
- 2.8 m/s

10. At the lowest point in a vertical dive (radius = 0.58 km), an airplane has a speed of 300 km/h which is not changing. Determine the magnitude of the acceleration of the pilot at this lowest point.

- 26 m/s²
- 21 m/s²

- 16 m/s²
- 12 m/s²
- 8.8 m/s²

11. The site from which an airplane takes off is the origin. The x axis points east; the y axis points straight up. The position and velocity vectors of the plane at a later time are given by

$$\vec{r} = (1.61 \times 10^4 \hat{i} + 9.00 \times 10^3 \hat{j}) \text{ m}$$

$$\vec{v} = (150 \hat{i} - 21 \hat{j}) \frac{\text{m}}{\text{s}}$$

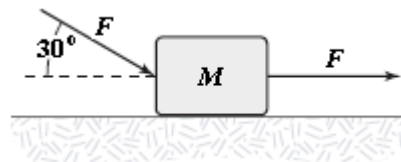
The magnitude, in meters, of the plane's displacement from the origin is

- 9.14×10^3 .
- 1.61×10^4 .
- 1.84×10^4 .
- $9.14 \times 10^3 t$.
- $1.61 \times 10^4 t$.

12. A car is driven 1 200 m north at 20.0 m/s and then driven 1 600 m east at 25.0 m/s. What is the magnitude of the average velocity for this trip?

- 16.1 m/s
- 22.6 m/s
- 31.3 m/s
- 11.3 m/s
- 62.2 m/s

13. The horizontal surface on which the block slides is frictionless. If $F = 20 \text{ N}$ and $M = 5.0 \text{ kg}$, what is the magnitude of the resulting acceleration of the block?

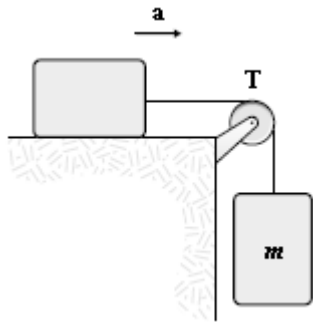


- 5.3 m/s²
- 6.2 m/s²
- 7.5 m/s²
- 4.7 m/s²
- 3.2 m/s²

14. A person weighing 0.70 kN rides in an elevator that has an upward acceleration of 1.5 m/s^2 . What is the magnitude of the force of the elevator floor on the person?
- 0.11 kN
 - 0.81 kN
 - 0.70 kN
 - 0.59 kN
 - 0.64 kN

15. The total force needed to drag a box at constant speed across a surface with coefficient of kinetic friction μ_k is least when the force is applied at an angle θ such that
- $\sin \theta = \mu_k$.
 - $\cos \theta = \mu_k$.
 - $\tan \theta = \mu_k$.
 - $\cot \theta = \mu_k$.
 - $\sec \theta = \mu_k$.

16. If the tension, T , is 15 N and the magnitude of the acceleration, a , is 3.0 m/s^2 , what is the mass, m , of the suspended object? Assume that all surfaces and the pulley are frictionless.



- 3.1 kg
- 2.5 kg
- 2.8 kg
- 2.2 kg
- 3.7 kg

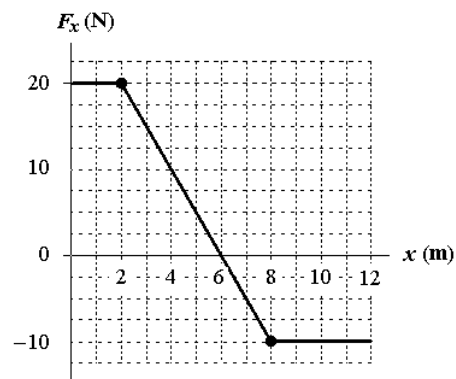
17. A stunt pilot weighing 0.70 kN performs a vertical circular dive of radius 0.80 km. At the bottom of the dive, the pilot has a speed of 0.20 km/s which at that instant is not changing. What force does the plane exert on the pilot?

- 3.6 kN up
- 4.3 kN up
- 2.9 kN down
- 2.9 kN up
- 5.8 kN down

18. A 0.40-kg mass attached to the end of a string swings in a vertical circle having a radius of 1.8 m. At an instant when the string makes an angle of 40 degrees below the horizontal, the speed of the mass is 5.0 m/s. What is the magnitude of the tension in the string at this instant?
- 9.5 N
 - 3.0 N
 - 8.1 N
 - 5.6 N
 - 4.7 N

19. If a dense 20.0-kg object is falling in air at half its terminal velocity, what is the drag force on the object at this moment?
- 24.5 N
 - 49.0 N
 - 69.3 N
 - 98.0 N
 - 139 N

20. An object moving along the x axis is acted upon by a force F_x that varies with position as shown. How much work is done by this force as the object moves from $x = 2 \text{ m}$ to $x = 8 \text{ m}$?



- 10 J
- +10 J
- +30 J
- 30 J
- +40 J

Motion in One Dimension

$$\text{average speed} \equiv \frac{\text{total distance}}{\text{total time}}$$

$$\Delta x \equiv x_f - x_i$$

$$\bar{v}_x \equiv \frac{\Delta x}{\Delta t}$$

$$v_x \equiv \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

$$\bar{a}_x \equiv \frac{\Delta v_x}{\Delta t}$$

$$a_x \equiv \lim_{\Delta t \rightarrow 0} \frac{\Delta v_x}{\Delta t} = \frac{dv_x}{dt}$$

$$v_{xf} = v_{xi} + a_x t$$

$$x_f - x_i = v_{xi} t + \frac{1}{2} a_x t^2$$

$$x_f - x_i = \bar{v}_x t = \frac{1}{2} (v_{xi} + v_{xf}) t$$

$$v_{xf}^2 = v_{xi}^2 + 2a_x (x_f - x_i)$$

Vectors

$$A_x = A \cos \theta$$

$$A_y = A \sin \theta$$

$$\vec{A} = A_x \hat{i} + A_y \hat{j}$$

$$A = \sqrt{A_x^2 + A_y^2}$$

$$\theta = \tan^{-1} \left(\frac{A_y}{A_x} \right)$$

Motion in Two Dimensions

$$\vec{r} = x\hat{i} + y\hat{j}$$

$$\Delta \vec{r} \equiv \vec{r}_f - \vec{r}_i$$

$$\bar{v} \equiv \frac{\Delta \vec{r}}{\Delta t}$$

$$\vec{v} \equiv \lim_{\Delta t \rightarrow 0} \frac{\Delta \vec{r}}{\Delta t} = \frac{d\vec{r}}{dt}$$

$$\vec{v} = \frac{dx}{dt} \hat{i} + \frac{dy}{dt} \hat{j}$$

$$\bar{a} \equiv \frac{\Delta \vec{v}}{\Delta t}$$

$$\vec{a} \equiv \lim_{\Delta t \rightarrow 0} \frac{\Delta \vec{v}}{\Delta t} = \frac{d\vec{v}}{dt}$$

$$\vec{v}_f = \vec{v}_i + \vec{a}t$$

$$\vec{r}_f = \vec{r}_i + \vec{v}_i t + \frac{1}{2} \vec{a}t^2$$

$$y = (\tan \theta_i) x - \left(\frac{g}{2v_i^2 \cos^2 \theta_i} \right) x^2$$

$$h = \frac{v_i^2 \sin^2 \theta_i}{2g} \quad R = \frac{v_i^2 \sin 2\theta_i}{g}$$

$$a_r = \frac{v^2}{r}, \quad a_t = \frac{dv}{dt}$$

$$\vec{a} = \frac{d|\vec{v}|}{dt} \hat{\theta} - \frac{v^2}{r} \hat{r}$$

$$\vec{v}' = \vec{v} - \vec{v}_0$$

$$\vec{a}' = \vec{a}$$

The Laws of Motion

$$\sum \vec{F} = m\vec{a}$$

$$\vec{F}_{12} = -\vec{F}_{21}$$

$$\vec{F}_g = m\vec{g}$$

$$f_k = \mu_k n$$

$$f_s \leq \mu_s n$$

$$F_{\text{spring}} = -kx$$

Circular Motion

$$\sum F_r = ma_r = \frac{mv^2}{r}$$

Work and Kinetic Energy

$$W \equiv Fd \cos \theta$$

$$\vec{A} \cdot \vec{B} \equiv AB \cos \theta = A_x B_x + A_y B_y + A_z B_z$$

$$W = \int_{x_i}^{x_f} F_x dx$$

$$K \equiv \frac{1}{2} mv^2$$

$$\sum W = \Delta K$$

$$K_i + \sum W_{\text{other}} - f_k d = K_f$$

$$\bar{\mathcal{P}} \equiv \frac{W}{\Delta t}$$

$$\mathcal{P} \equiv \lim_{\Delta t \rightarrow 0} \frac{W}{\Delta t} = \frac{dW}{dt} = \vec{F} \cdot \vec{v}$$