

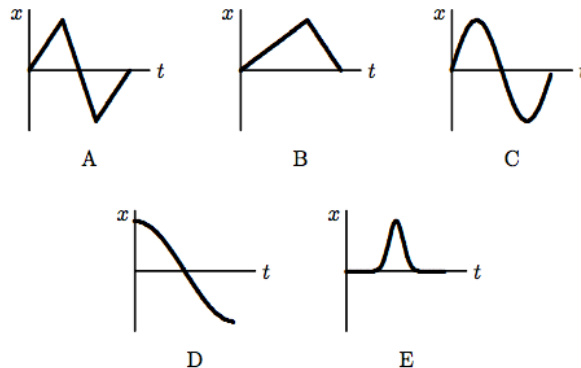
# Physics 2101, First Exam, Spring 2010

February 3, 2010

- Please turn OFF your cell phone!
- Write down your name and section number in the scantron form.
- Make sure to mark your answers in the scantron form.
- You can mark your answers in this exam form too, and keep it for reference.
- Feel free to detach, use and keep the formula sheet. No other reference material is allowed during the exam.
- You may use scientific or graphing calculators, but not your phone's calculator.

1. A sphere has a radius of 21 cm and a mass of 1.9 kg. Its mass density is about:
  - (a)  $2.0 \times 10^{-6} \text{kg/m}^3$
  - (b)  $2.0 \times 10^{-2} \text{kg/m}^3$
  - (c)  $1.4 \text{kg/m}^3$
  - (d)  $14 \text{kg/m}^3$
  - (e)  $49 \text{kg/m}^3 \leftarrow \rho = m/V = m/((4/3)\pi r^3)$
2. A car travels 40 kilometers at an average speed of 80 km/h and then travels 40 kilometers at an average speed of 40 km/h. The average speed of the car for this 80-km trip is:
  - (a) 40 km/h
  - (b) 45 km/h
  - (c) 48 km/h
  - (d)  $53 \text{ km/h} \leftarrow v_{avg} = D/T = 80 \text{km}/1.5 \text{h} = 53 \text{km/h}$
  - (e) 60 km/h
3. A car moves from rest on a straight line. The car initially speeds up; a short time later it decelerates to a stop and then it returns to its original position in a similar manner: First it speeds up and then slows down to a stop. Which of the following five position versus time graphs best describes the motion?

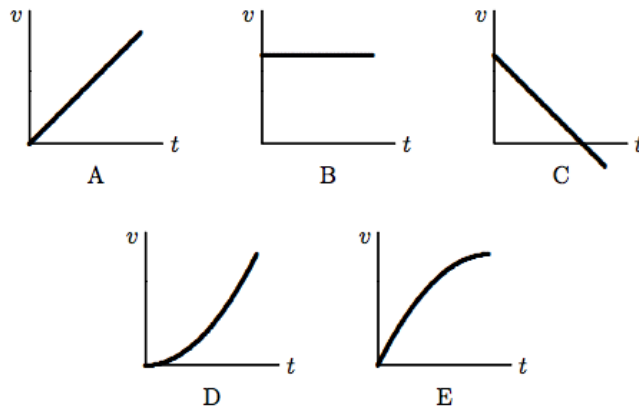
Answer: (e)



4. Of the following situations, which one is impossible?
  - (a) A body having velocity east and acceleration east
  - (b) A body having velocity east and acceleration west
  - (c) A body having zero velocity and non-zero acceleration
  - (d) A body having constant acceleration and changing velocity
  - (e) A body having constant velocity and changing acceleration  $\leftarrow$

5. A car, initially at rest, travels 20 m in 4 s along a straight line with constant acceleration. The acceleration of the car is:
- (a)  $0.4\text{m/s}^2$
  - (b)  $1.3\text{m/s}^2$
  - (c)  $2.5\text{m/s}^2 \leftarrow x = (1/2)at^2, a = 2x/t^2 = 2 \times 20\text{m}/(4\text{s})^2 = 2.5\text{m/s}^2$
  - (d)  $4.9\text{m/s}^2$
  - (e)  $9.8\text{m/s}^2$
6. An object is thrown vertically upward at 35 m/s. Taking  $g = 10 \text{ m/s}^2$ , the velocity of the object 5 s later is:
- (a) 7.0 m/s up
  - (b) 15 m/s down  $\leftarrow v = v_0 - gt = 35\text{m/s} - 10\text{m/s}^2 \times 5\text{s} = -15\text{m/s}$
  - (c) 15 m/s up
  - (d) 85 m/s down
  - (e) 85 m/s up
7. A ball is in free fall. Its acceleration is:
- (a) downward during both ascent and descent  $\leftarrow$
  - (b) downward during ascent and upward during descent
  - (c) upward during ascent and downward during descent
  - (d) upward during both ascent and descent
  - (e) downward at all times except at the very top, when it is zero
8. An object is thrown vertically into the air. Which of the following five graphs represents the velocity ( $v$ ) of the object as a function of the time ( $t$ )? The positive direction is taken to be upward.

Answer: (C)  $v(t) = v_0 - gt$



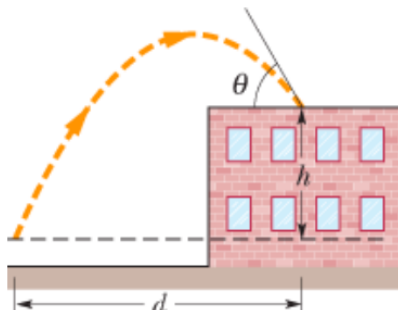
9. If we choose the x-axis pointing to the right and the y-axis pointing up, the vector  $\vec{A} = (6\text{m})\hat{i} - (6\text{m})\hat{j}$  points:

- (a) up and to the right
- (b) up and to the left
- (c) down and to the right  $\leftarrow$
- (d) down and to the left
- (e) nowhere, it's zero.

10. If  $\vec{A} = (6\text{m})\hat{i} - (6\text{m})\hat{j}$  then the vector  $4\vec{A}$  has magnitude:

- (a) 0 m
- (b) 12m
- (c) 48 m
- (d) 8.5 m
- (e) 33.9 m  $\leftarrow$

In the figure below the ball is thrown up onto a roof, landing some time later at height  $h$  above and  $d$  horizontally from the release point.



11. If the speed of the ball just before it lands on the roof is  $v_f$ , what is the velocity vector at the time  $t$  just before it lands on the roof? (Up and to the right are positive directions)
  - (a)  $v_f \cos \theta \hat{i} + v_f \sin \theta \hat{j}$
  - (b)  $v_f \cos \theta \hat{i} - v_f \sin \theta \hat{j} \leftarrow$
  - (c)  $-gt \hat{j}$
  - (d)  $v_f \cos \theta \hat{i} + (v_f \sin \theta - gt)\hat{j}$
  - (e)  $v_f \cos \theta \hat{i} - (v_f \sin \theta + gt)\hat{j}$
  
12. In the figure above, we know that  $h = 20$  m and  $d = 30$  m. The ball's speed when the ball reaches its highest point is 10 m/s. How long does the ball take to land on the roof, from the time it leaves the ground ?
  - (a) 2s
  - (b) 3s  $\leftarrow$
  - (c) 1.5s
  - (d) 3.83s
  - (e) Not enough information

Tornado Smith is driving a motorcycle around a loop-de-loop at constant speed in a vertical circle.



13. The instantaneous velocity and instantaneous acceleration vectors of the motorcycle are:
- (a) both tangent to the circular path
  - (b) both perpendicular to the circular path
  - (c) perpendicular to each other ←
  - (d) opposite to each other
  - (e) none of the above
14. The motorcycle speed is  $5\text{m/s}$  in a vertical circle with radius  $2\text{m}$ . The acceleration of the motorcycle at the bottom of the circle is
- (a)  $9.8\text{m/s}^2$ , up
  - (b)  $9.8\text{m/s}^2$ , down
  - (c)  $50\text{m/s}^2$ , up
  - (d)  $12.5\text{m/s}^2$ , up ←  $a = v^2/r$ , pointing to the center of the circle
  - (e)  $12.5\text{m/s}^2$ , down
15. At the bottom of the circle, the normal force on the motorcycle will be
- (a) larger than the motorcycle and driver's weight, up. ←
  - (b) smaller than the motorcycle and driver's weight, down.
  - (c) equal to the motorcycle and driver's weight, up.
  - (d) equal to the motorcycle and driver's weight, down.
  - (e) zero.

A worker pushes horizontally on a crate of mass  $M$  across a floor with a force of magnitude  $F$ , as shown in the figure on the left. There is friction between the floor and the crate with coefficient  $\mu_k$ . This force results in an acceleration of the crate of magnitude  $a$ . An identical crate is attached to the top of the first crate and the system is pushed with the same force  $F$  resulting in an acceleration of  $a/4$ , as shown in the figure on the right.



16. What is the magnitude of  $a$ ?

On the left system,

$$F = ma - \mu_k F_N = ma - \mu_k mg.$$

On the right system,

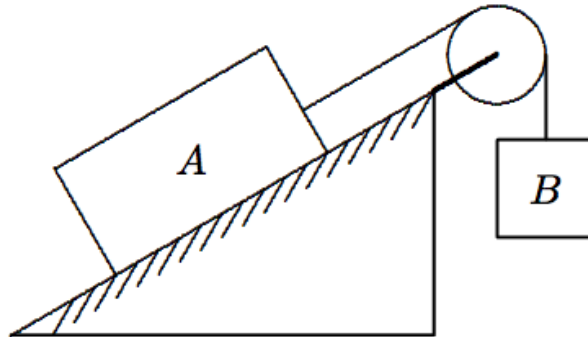
$$F = (2m)a/4 - \mu_k F_N = ma/2 - \mu_k 2mg.$$

Thus,

$$ma - \mu_k mg = ma/2 - \mu_k 2mg \Rightarrow ma/2 = \mu_k mg \text{ and } a = 2\mu_k g$$

- (a)  $\mu_k g$
  - (b)  $2\mu_k g$
  - (c)  $\mu_k g/2$
  - (d)  $4\mu_k g$
  - (e)  $\mu_k g/4$
17. What is the direction of the net force on the upper crate?
- (a) points up and to the right
  - (b) points up and to the left
  - (c) points to the right  $\leftarrow$  Since the upper crate is accelerating to the right, the net force must point to the right.
  - (d) points to the left
  - (e) points down

In the figure shown, assume the plane is frictionless, and ignore the mass of the pulley. The incline has an angle  $\theta = 30^\circ$ .



18. If  $m_A = m_B$  and the system is initially at rest, which of the following is true?
- (a) The system will remain at rest.
  - (b) Mass B is moving down with a constant speed.
  - (c) Mass B is moving down with a constant acceleration.  $\leftarrow$
  - (d) Mass B is moving up with a constant speed.
  - (e) Mass B is moving up with a constant acceleration.
19. In the same figure, assume now that mass B is not yet attached, but mass A, which weighs 10N, is in equilibrium due to a force of static friction. What is the magnitude and direction of the static friction force on A?
- (a) 10 N, up the incline
  - (b) 10 N, down the incline
  - (c) 5 N, up the incline  $\leftarrow$
  - (d) 5 N, down the incline
  - (e) We need to know the coefficient of static friction.
20. Consider now a mass B weighing 10 N attached to the system. Now mass B is moving down and mass A (still weighing 10N) is moving up the incline, both with a constant speed  $v$ . What is the friction force on mass A?
- (a) 10 N, up the incline
  - (b) 5 N, up the incline
  - (c) 10 N, down the incline
  - (d) 5 N, down the incline  $\leftarrow$
  - (e) 0 N