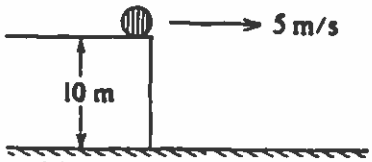
MIDTERM EXAM
AP Physics

1. 

An object slides off a roof 10 meters above the ground with an initial horizontal speed of 5 meters per second as shown above. The time between the object's leaving the roof and hitting the ground is most nearly

(A) $\frac{1}{2}$ s (B) $\frac{1}{\sqrt{2}}$ s (C) $\sqrt{2}$ s (D) 2 s (E) $5\sqrt{2}$ s

2. A body moving in the positive x direction passes the origin at time t = 0. Between t = 0 and t = 1 second, the body has a constant speed of 24 meters per second. At t = 1 second, the body is given a constant acceleration of 6 meters per second squared in the negative x direction. The position x of the body at t = 11 seconds is

(A) +99 m (B) +36 m (C) -36 m (D) -75 m (E) -99 m

3. Two people are in a boat that is capable of a maximum speed of 5 kilometers per hour in still water, and wish to cross a river 1 kilometer wide to a point directly across from their starting point. If the speed of the water in the river is 5 kilometers per hour, how much time is required for the crossing?

(A) 0.05 hr (B) 0.1 hr (C) 1 hr (D) 10 hr
(E) The point directly across from the starting point cannot be reached under these conditions.

4. A projectile is fired from the surface of the Earth with a speed of 200 meters per second at an angle of 30° above the horizontal. If the ground is level, what is the maximum height reached by the projectile?

(A) 5 m (B) 10 m (C) 500 m (D) 1,000 m (E) 2,000 m

5. A particle moves along the x-axis with a nonconstant acceleration described by a = 12t, where a is in meters per second squared and t is in seconds. If the particle starts from rest so that its speed v and position x are zero when t = 0, where is it located when t = 2 seconds?

(A) x = 12 m (B) x = 16m (C) x = 24 m (D) x = 32 m (E) x = 48 m

Questions 6-7

An object moving in a straight line has a velocity v in meters per second that varies with time t in seconds according to the following function.

$v = 4 + 0.5\,t^2$

6. The instantaneous acceleration of the object at t = 2 seconds is

   (A) 2 m/s^2 (B) 4 m/s^2 (C) 5 m/s^2 (D) 6 m/s^2 (E) 8 m/s^2

7. The displacement of the object between t = 0 and t = 6 seconds is

   (A) 22 m (B) 28 m (C) 40 m (D) 42 m (E) 60 m

8. A rock is dropped from the top of a 45-meter tower, and at the same time a ball is thrown from the top of the tower in a horizontal direction. Air resistance is negligible. The ball and the rock hit the level ground a distance of 30 meters apart. The horizontal velocity of the ball thrown was most nearly

   (A) 5 m/s (B) 10 m/s (C) 14.1 m/s (D) 20 m/s (E) 28.3 m/s

9. In the absence of air friction, an object dropped near the surface of the Earth experiences a constant acceleration of about 9.8 m/s^2. This means that the

   (A) speed of the object increases 9.8 m/s during each second
   (B) speed of the object as it falls is 9.8 m/s
   (C) object falls 9.8 meters during each second
   (D) object falls 9.8 meters during the first second only
   (E) derivative of the distance with respect to time for the object equals 9.8 m/s^2

10. A 500-kilogram sports car accelerates uniformly from rest, reaching a speed of 30 meters per second in 6 seconds. During the 6 seconds, the car has traveled a distance of

    (A) 15 m (B) 30 m (C) 60 m (D) 90 m (E) 180 m

11. At a particular instant, a stationary observer on the ground sees a package falling with speed v_1 at an angle to the vertical. To a pilot flying horizontally at constant speed relative to the ground, the package appears to be falling vertically with a speed v_2 at that instant. What is the speed of the pilot relative to the ground?

    (A) $v_1 + v_2$ (B) $v_1 - v_2$ (C) $v_2 - v_1$ (D) $\sqrt{v_1^2 - v_2^2}$ (E) $\sqrt{v_1^2 + v_2^2}$

12. An object is shot vertically upward into the air with a positive initial velocity. Which of the following correctly describes the velocity and acceleration of the object at its maximum elevation?

Velocity	Acceleration
(A) Positive	Positive
(B) Zero	Zero
(C) Negative	Negative
(D) Zero	Negative
(E) Positive	Negative

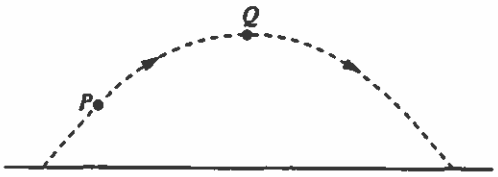
13. A particle of mass m moves along a straight path with a speed v defined by the function $v = bt^2 + c$, where b and c are constants and t is time. What is the magnitude F of the net force on the particle at time $t = t_1$?

(A) $bt_1^{\,2} + c$ (B) $3mbt_1 + 2c$ (C) mbt_1 (D) $mbt_1 + c$ (E) $2mbt_1$

14. A spring-loaded gun can fire a projectile to a height h if it is fired straight up. If the same gun is pointed at an angle of 45° from the vertical, what maximum height can now be reached by the projectile?

(A) h/4 (B) $\frac{h}{2\sqrt{2}}$ (C) h/2 (D) $\frac{h}{\sqrt{2}}$ (E) h

Questions 16-17



A ball is thrown and follows a parabolic path, as shown above. Air friction is negligible. Point Q is the highest point on the path.

15. Which of the following best indicates the direction of the acceleration, if any, of the ball at point Q?

(A) → (B) ↘ (C) ↓ (D) ←

(E) There is no acceleration of the ball at point Q.

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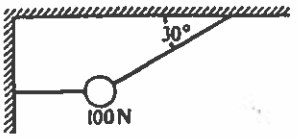
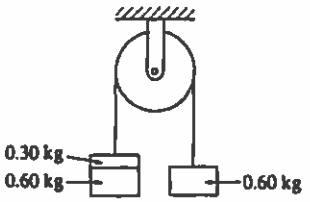
17. 

A 100-newton weight is suspended by two cords as shown in the figure above. The tension in t slanted cord is

(A) 50 N (B) 100 N (C) 150 N (D) 200 N (E) 250 N

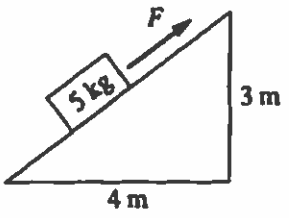
18. From the top of a 70-meter-high building, a l-kilogram ball is thrown directly downward with an initial speed of 10 meters per second. If the ball reaches the ground with a speed of 30 meters per second, the energy lost to friction is most nearly

(A) 0J (B) 100 J (C) 300 J (D) 400 J (E) 700

19. 

Two 0.60-kilogram objects are connected by a thread that passes over a light, frictionless pulley, as shown above. The objects are initially held at rest. If a third object with a mass of 0.30 kilogram is added on top of one of the 0.60-kilogram objects as shown and the objects are released, the magnitude of the acceleration of the 0.30-kilogram object is most nearly

(A) 10.0 m/s^2 (B) 6.0 m/s^2 (C) 3.0 m/s^2 (D) 2.0 m/s^2 (E) 1.0 m/s^2

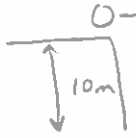
20. 

A block of mass 5 kilograms lies on an inclined plane, as shown above. The horizontal and vertical supports for the plane have lengths of 4 meters and 3 meters, respectively. The coefficient of friction between the plane and the block is 0.3. The magnitude of the force F necessary to pull the block up the plane with constant speed is most nearly

(A) 30 N (B) 42 N (C) 49 N (D) 50 N (E) 58 N

MIDTERM EXAM REVIEW

1. [C]



$v_{0y} = 0$

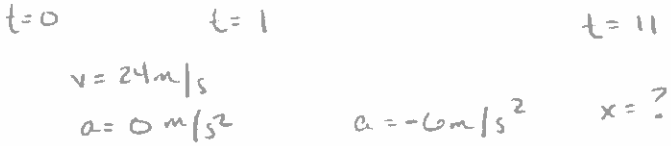
$\Delta y = v_0 t + \frac{1}{2} a t^2$

$-10 = \frac{1}{2}(-10) t^2$

$2 = t^2$

$\boxed{\sqrt{2} = t}$

2. [C]



$x(1s) = vt = 24(1) = 24m$

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

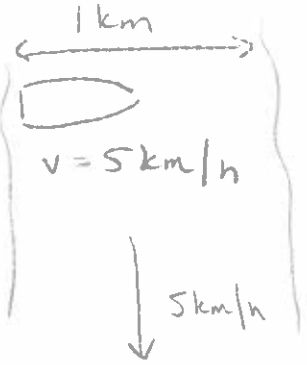
$\Delta x\,(1-11s) = 24(10) + \frac{1}{2}(-6)(10)^2$

$\Delta x = 240 - 300$

$\Delta x = -60m$

$24 - 60 = \boxed{-36m}$

3. [E]



to go directly across they would have to angle upstream to counteract the current. Even if they go directly upstream, the best they can do is stay in one place. so they cannot reach a point directly across.

5 km/h ↑ ↓ 5 km/hr.

4. [C]

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

$0^2 = (200 \sin 30)^2 + 2(-10)\Delta y$

$0 = 100^2 - 20\Delta y$

$\boxed{\Delta y = 500m}$

5. $a = 12t$

B

@ $t = 0s$ $v(0) = 0 m/s$ $x(0) = 0m$

$v = \int a\,dt$

$v = 6t^2 + C$

$v(0) = 6(0)^2 + C = 0$

$C = 0$

$v = 6t^2$

$x = \int 6t^2\,dt$

$x = 2t^3 + C$

$x(0) = 2(0)^3 + C = 0$

$C = 0$

$x = 2t^3$

$x(2) = 2(2)^3$

$\boxed{x = 16m}$

6. $v = 4 + 0.5t^2$

A

$a = \frac{dv}{dt} = \frac{d}{dt}\left(4 + 0.5t^2\right)$

$a = 1t$

$\boxed{a(2) = 2 m/s^2}$

7. $x = \int 4 + 0.5t^2\,dt = 4t + \frac{0.5}{3}t^3 + C$

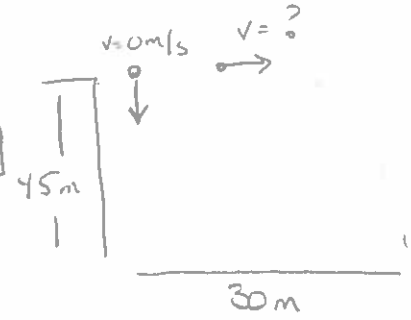
E

$x(6) - x(0) = \left[4(6) + \frac{0.5}{3}(6)^3 + C\right] - [C]$

$= 24 + 36 = \boxed{60m}$

8.

B



ball dropped:

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

$-45 = 0t + \frac{1}{2}(-10)t^2$

$-45 = -5t^2$

$t = 3s$

ball thrown:

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

$30 = v_0(3)$

$\boxed{v_0 = 10 m/s}$

9. A $a = \Delta v$ $a = -9.8 m/s/s$ ← for each second, the speed increases $-9.8 m/s$.

10. $v = v_0 + at$

D

$30 = 0 + a(6)$

$a = 5 m/s^2$

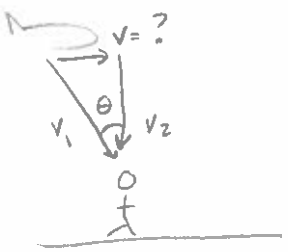
$v^2 = v_0^2 + 2a\Delta x$

$30^2 + 0^2 + 2(5)\Delta x$

$900 = 10\Delta x$

$\boxed{90 m = \Delta x}$

11. [D]



$v_1^2 = v_2^2 + v^2$

$\sqrt{v_1^2 - v_2^2} = v$

12. [D]

$a_y = -9.8\ m/s^2$

$v_{top} = 0\ m/s$

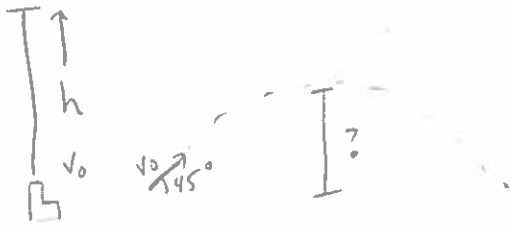
13. [E] $v = bt^2 + c$

$a = \frac{dv}{dt} = \frac{d}{dt}\ bt^2 + c$

$a = 2bt_1$

$F = ma = 2mbt_1$

14. [C]



$v^2 = v_0^2 + 2ah$

$0 = v_0^2 + (-20)h$

$h = \frac{1}{20} v_0^2$

$\sin 45 = \frac{\sqrt{2}}{2}$

$v_{0y} = \frac{v_0\sqrt{2}}{2}$

$v^2 = v_0^2 + 2(-10)\Delta y$

$0^2 = \left(\frac{\sqrt{2}}{2} v_0\right)^2 - 20\Delta y$

$0 = \frac{2}{4} v_0^2 - 20\Delta y$

$-\frac{1}{2} v_0^2 = -20y$

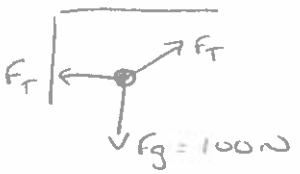
$\frac{1}{40} v_0^2 = \Delta y$

15. [C] grav. to 0

16. [C]

17

D



$$\sin 30 = \frac{100}{F_T}$$

$$F_T = \frac{100}{\sin 30} = 200N$$

18. ENERGY - NOT ON MIDTERM

19.

D

.9 ↓ $F_g = .9(10)$

$F_g = 9N$

.6 ↓ $F_g = .6(10)$

$F_g = 6N$

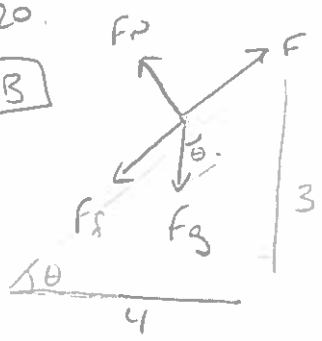
$$9N - 6N = (.9 + .6)a$$

$$3 = 1.5a$$

$$2 m/s^2 = a$$

20.

B



$$\tan\theta = \frac{3}{4}$$

$$\theta = 37°$$

$\Sigma F_x = 0$ ← constant v

$$F - F_f - F_{gx} = 0$$

$$F - \mu F_N - F_g \sin 37 = 0$$

$$F - .3(40) - 50 \sin 37 = 0$$

$$F - 12 - 30 = 0$$

$$\boxed{F = 42N}$$

$$\Sigma F_y = 0$$

$$F_N - F_{gy} = 0$$

$$F_N = F_{gy}$$

$$F_N = 5(10)\cos 37$$

$$F_N = 40N$$