Arts & Science 2D06

Quiz #2 **2017 Oct 18** **Name:** Solutions

NB: Mark values are given in brackets [ ] beside each problem. Write all your answers on the quiz paper. No books or notes allowed. Time to write quiz: 50 minutes.

Solution for quadratic equation: $x = (-b \pm \sqrt{b^2 - 4ac})/2a$

Uniform acceleration: $x = x_0 + v_0 t + \frac{1}{2}at^2$ $v^2 = v_0^2 + 2a(x - x_0)$ $v = v_0 + at$

$g = 9.8$ m/s^2 centripetal $a_c = v^2/r$ linear K.E. $= (1/2)mv^2$

Energy conservation $E = K + U$

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1. [3] Suppose that you are standing in a moving bus, facing forward. The bus is moving at constant speed, and you suddenly move forward as the bus comes to a sudden stop. What force caused you to move forward?

(Explain/derive your answer in the space below.)

(a) The force of gravity.

(b) The normal force due to your contact with the floor of the bus.

(c) The force due to static friction between you and the floor of the bus.

(d) The force due to kinetic friction between you and the floor of the bus.

→(e) No forces were responsible for your forward motion.

The forces causing the bus' deceleration are not acting on you.

Since you were moving at constant speed before the deceleration, you will continue in this state of motion. (Newton's 1st law)

∴ No forces caused your forward motion.

2. [3] When an object moves at constant speed on a circular path, which of the following is true?

(Choose one statement; you can explain your answer if you would like, but it is not required.)

(a) A net force, pointing along the direction of motion, acts on the object.

(b) A net force, pointing along the opposite direction of motion, acts on the object.

(c) A net force, pointing away from the center of the circle, acts on the object.

→ (d) A net force, pointing towards the center of the circle, acts on the object.

(e) The net force acting on the object is zero.

Circular motion : acceleration $\vec{a}$ points toward centre of circle

Since $m\vec{a} = \vec{F}_{net}$, $\vec{F}_{net}$ points toward the circle's centre, too.

3. [4] A car on a roller coaster starts from rest at an elevation of 26 m above the ground. It coasts down a slope, and then climbs a hill. The top of the hill is at an elevation of 16 m (above the ground). What is the speed of the car at the top of the hill? (Ignore friction and air resistance.)

Conservation of energy :

$$E_0 = E_f$$

$$mgh_0 = \frac{1}{2}mv_f^2 + mgh_f$$

$$v_f^2 = 2g(h_0 - h_f)$$

$$v_f = \sqrt{2g(h_0 - h_f)} = \sqrt{2(9.8)(26-16)}$$

$$\therefore \underline{v_f = 14 \text{ m/s}}$$

4. [5] A 5.0-kg object moves clockwise around a circular path of 50-cm radius. At one location, the speed of the object is 4.0 m/s. When the object next returns to this same location, the speed is 3.0 m/s.

(a) How much work was done by "dissipative forces" (e.g. friction and air resistance), as the object moved once around the circle?

(b) If the combined magnitude of the these dissipative forces is constant, what is the value of this magnitude?

(a) $W_d = \Delta K = K_f - K_i = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

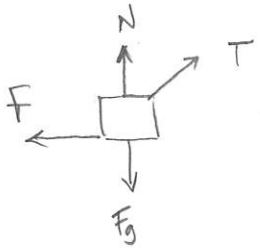
$\therefore \quad W_d = \frac{1}{2}(5)(3^2 - 4^2) = \underline{-17.5\,J}$

(b) $W_d = F_d \cdot \Delta x \cdot \cos\theta \; ; \quad \theta = 180^\circ \; , \quad \Delta x = 2\pi r = 2\pi(0.5) = 3.14\,m$

$\therefore \quad -17.5 = F_d\,(3.14)(-1)$

$\Rightarrow \quad \underline{F_d = 5.6\,N}$

5. [5] A 10-kg box is pulled by a rope along a horizontal surface (see figure below), and experiences an acceleration of 1.5 m/s^2. Find the coefficient of kinetic friction between the box and the ground, if the tension in the rope is 50 N.



• y: $\sum F_y = ma_y$

$T\sin 70° + N - mg = 0$

$N = mg - T\sin 70°$

$= (10)(9.8) - 50\sin 70°$

$\therefore N = 51\ N$

• x: $\sum F_x = ma_x$

$T\cos 70° - F = ma_x$

$f = T\cos 70° - ma_x$

$\mu_k = \dfrac{T\cos 70° - ma_x}{N} = \dfrac{50\cos 70° - 10(1.5)}{51}$

$\therefore \underline{\mu_k = 0.04}$

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[20] total marks