Arts & Science 2D06

Quiz #2   2012 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: 40 minutes.

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

Equations of motion for uniform acceleration: $x = x_0 + v_0 t + \frac{1}{2}at^2$, $v^2 = v_0^2 + 2ax$

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

Gravitational potential energy: $U = mgy$ Spring potential energy: $U = (1/2)kx^2$

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1. [3] An object is moving with constant velocity. Which statement(s) must be true? Explain your choice(s) in the space below.

(a) The net force on the object is zero. ✗

(b) A small net force is acting on the object, in the direction of motion.

(c) No forces are acting on the object.

(d) The object is moving in a circle.

(a) constant velocity $\Rightarrow \vec{a} = 0 \therefore \sum_i \vec{F} = 0$ (no net force).

(b) wrong, b/c of (a).

(c) $\sum_i \vec{F} = 0$, but forces can be acting on the object.

(d) not true; direction of $\vec{v}$ changes in circular motion.

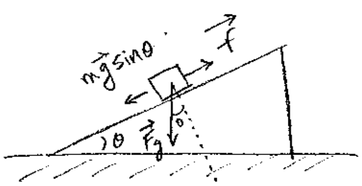
2. [3] A block is at rest on a rough incline. The frictional force acting on the block, along the incline, is: (Explain your answer in the space below)

(a) Zero.

(b) Equal to the weight of the block.

(c) Greater than the weight of the block.

(d) Less than the weight of the block. ✗

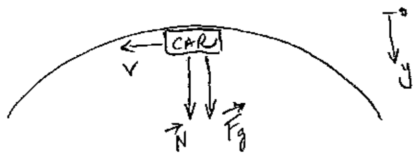


@ rest $\Rightarrow$ $mg\sin\theta = f$

Since $\sin\theta < 1$, $f < mg$ (weight of block)

3. [4] A toy car with mass 0.8 kg moves with uniform speed on the inside of a track that is a vertical circle of radius 6.0 m. If the normal force exerted by the track on the toy when it is at the top of the track is 9.0 N, calculate the normal force on the car when it is at the bottom of the track.

top



$$\sum F_y = \frac{mv^2}{r}$$

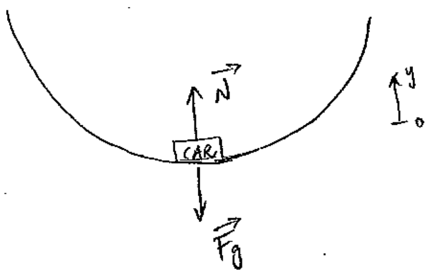
$$F_g + N = \frac{mv^2}{r}$$

$$v = \sqrt{\frac{r}{m}(F_g + N)}$$

$$= \sqrt{\frac{6}{0.8}((0.8)(9.81) + 9)}$$

$$= 11.2 \text{ m/s}$$

bottom



$$\sum F_y = \frac{mv^2}{r}$$

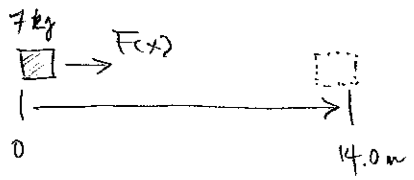
$$N - F_g = \frac{mv^2}{r}$$

$$N = \frac{mv^2}{r} + F_g = \frac{(0.8)(11.2)^2}{6} + (0.8)(9.81)$$

$$= 16.7 + 7.85$$

$$= 24.6 \text{ N}$$

4. [5] A force in the positive x-direction has a magnitude $F(x) = 15.0N - (0.35N/m)x$. This force is applied to a 7-kg box that is sitting on the horizontal (frictionless) surface of a frozen pond. If the box is initially at $x = 0$ and at rest, what is the box's speed after it has traveled 14.0 m?



$$W = \int_0^{14} (15 - 0.35x)\,dx = 15x - 0.175x^2 \Big|_0^{14} = 210 - 34.3 = 175.7\text{ J}$$

$$W = \frac{1}{2} m V_f^2 - \frac{1}{2} m V_0^2 \quad (\to 0)$$

$$\therefore \quad V_f = \sqrt{\frac{2W}{m}} = \sqrt{\frac{2 \cdot 175.7\text{ J}}{7}} = \sqrt{50.2} = 7.1\text{ m/s}$$

5. [5] A 2.60-kg book is pushed against a horizontal spring of negligible mass and with a stiffness constant of 240 N/m. The spring is compressed a distance of 0.22 m. When released, the book slides on a horizontal surface that has a coefficient of kinetic friction of 0.35. Find how far the book moves from its position of release before coming to a stop.

- compression: $U_{spring} = \frac{1}{2} k x^2 = \frac{1}{2}(240)(0.22)^2 = 5.81\ J$

- Upon release: (ignoring friction) $K_{book} = U_{spring} = 5.81\ J$

$$W = F_f \cdot \Delta x = 5.81\ J$$

$$\Delta x = \frac{5.81\ J}{F_f} = \frac{5.81}{(0.35)(2.6)(9.81)} = 0.65\ m$$

[20] total marks