Arts & Science 2D06

Quiz #2 2014 Oct 9 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: $x = (-b \pm \sqrt{b^2 - 4ac})/2a$

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

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

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1. [3] You try to pull a car by tugging on a rope attached to it, but the car does not move. Which of the following is the most likely conclusion?

(Explain your answer in the space below.)

(a) The car's inertia prevents it from accelerating.

(b) The car is in its natural state of rest and can no longer be set into motion.

(c) The rope is not transmitting the force to the car.

→ (d) There are other forces acting on the car besides the one you're exerting.

(e) The car is parked on top of a very high mountain.

(d) $\vec{a} = 0 \Rightarrow \vec{F}_{NET} = 0$ ∴ your force is cancelled by the sum of the other forces.

2. [3] If the net force applied to an object is plotted as a function of the object's displacement, what feature of this plot gives us the work done by the force on the object?

(a) The slope of any straight part of the curve.

→ (b) The area under the curve.

(c) The average value of the curve over the entire displacement.

(d) None - the work can't be figured out from the plot.

(e) None of the above.

(No explanation required)

3. [4] Suppose that to stretch a certain spring 0.25 m from its equilibrium length, you need to exert 36 J of work. How much more work will it take to stretch this spring by an additional 0.25 m?

$W_1 = \frac{1}{2} k x_1^2$, where $x_1 = 0.25\ m$

$36 = \frac{1}{2} k (0.25)^2$

$k = 1152\ N/m$

$\therefore \quad W_2 = \frac{1}{2} k x_2^2$, where $x_2 = 0.50 m$

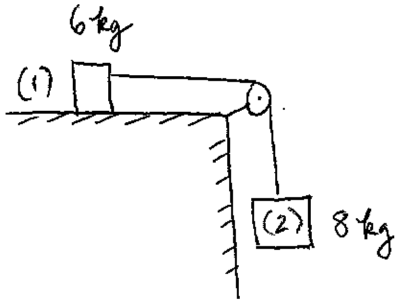
$= \frac{1}{2} (1152)(0.50)^2$

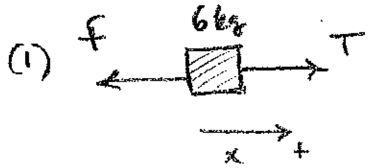
$= 144\ J$

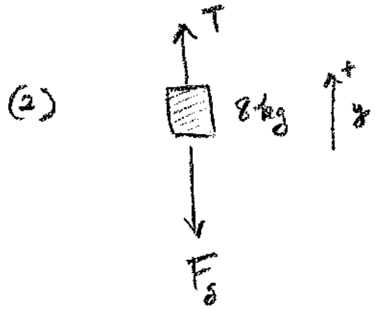
so $W_2 - W_1 = 108\ J$

4. [5] Consider the mass-pulley system shown in the figure below. What must be the surface's coefficient of static friction if the masses are not moving?

(Assume that the rope is taut and massless; and ignore the friction between the rope and pulley.)







$\therefore$ from (2) : $\sum_i F_y = m_2 a_y = 0$

$T - F_g = 0$

$T = F_g = m_2 g = 78.5\,N$

from (1) : $\sum_i F_x = m_1 a_x = 0$

$T - f = 0$, but $T = 78.5\,N$

so, $f = 78.5\,N$

$\mu_s N = 78.5\,N$

$\mu_s = \dfrac{78.5}{m_1 g} = 1.3$

(NOTE: technically, this is the <u>smallest</u> possible value for μ_s)

5. [5] In an emergency-braking situation, a certain car requires 8.0 m to come to a stop from an initial speed of 12 m/s. If the car's initial speed is 30 m/s instead, estimate the required braking distance for this new speed. (State any assumptions that you make.)

$$W = K_f - K_i = 0 - \frac{1}{2} M v_i^2$$

$$W = -72\,M$$

• Assume that deceleration is caused by a constant force F:

$$W = F \cdot \Delta x = -72\,M$$

$$\therefore \quad \frac{F}{M} = -\frac{72}{8} = -9 \ \text{N/kg}$$

So, for $V_i = 30$ m/s

$$F \cdot \Delta x = -\frac{1}{2} M (30)^2$$

$$\Delta x = -\frac{450}{(F/M)} = -\frac{450}{(-9)} = 50 \text{ m.}$$

[20] total marks