Physics 1205 – Exam #2
October 17, 2008

Name (Print):____Key____________________________

My signature below is a statement that all work contained in this exam is my own work. I have not copied work from any other source, or used any material other than one 3 by 5 card and my calculator.

Name (Signature):_________________________________

DO NOT TURN THIS PAGE OVER UNTIL YOU ARE INSTRUCTED TO DO SO.

STOP WORKING ON THIS EXAM AS SOON AS YOU ARE INSTRUCTED TO DO SO.

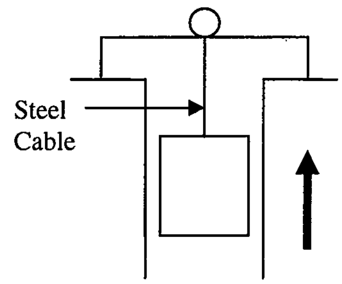
You will have approximately 1 hour to do this exam

- The following exam consists of 8 multiple-choice questions and 2 worked problems.
    - Point values are assigned to each problem in the exam.
- It is a good idea to first skim through the entire test and begin with the problems that seem most familiar. If you get stuck on a problem, skip to another.
- For the computational problems, please show all problem solving steps and all your work.
    - All work must be done on the pages provided.
    - Please write neatly and put a BOX around your final answer.
    - Use significant figures in your answers.
- Calculators may be used only to do arithmetic. You cannot use your calculator for solving algebraic equations, for graphing, for vectors, etc.

Problem #	Max Points	Score	Problem #	Max Points	Score
1	5		6	5	
2	5		7	5	
3	5		8	5	
4	5		9	30	
5	5		10	30	
			Total	100	

1. An elevator is being lifted up a shaft by a steel cable. Assuming there is no friction, when the elevator is moving up the shaft at a constant velocity, the forces on the elevator are such that

- ☐ the upward force of the cable is greater than the downward force of gravity.
- ☒ the upward force of the cable equals the downward force of gravity.
- ☐ the upward force of the cable is smaller than the downward force of gravity.
- ☐ the upward force of the cable is greater than the sum of the downward force of gravity and a downward force due to air.
- ☐ none of the above. (The elevator goes up because the cable is being shortened, not because of the force being exerted on the elevator by the cable.)



Elevator moving up at a constant velocity

$\Sigma F = 0$

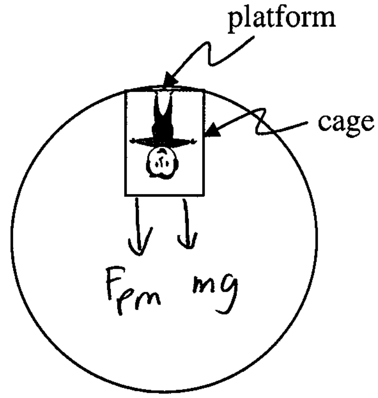
$F_{cable} - mg = 0$

$F_{cable} = mg$

2. Your car is stalled, so you push it in order to get it started. During the time when you are pushing the car and speeding up, which of the following statements is true?

- ☐ Neither the car nor you exert any force on the other.
- ☐ You exert a force on the car, but the car does not exert any force on you.
- ☒ The magnitude of the force that you exert on the car is equal to the magnitude of the force the car exerts you.
- ☐ The magnitude of the force that you exert on the car is less than the magnitude of the force the car exerts on you, but neither force is zero.
- ☐ The magnitude of the force that you exert on the car is greater than the magnitude of the force the car exerts on you, or the car would not accelerate forward, but neither force is zero.

3. In a carnival ride, a man with mass *m* stands on a platform in a cage that is attached to a giant wheel that spins in the vertical direction. The wheel spins so fast that the man in the cage exerts a force on the platform that is equal to his own weight when the cage is at the top of the wheel and the man is upside down. At this point, the *net force* on the man is

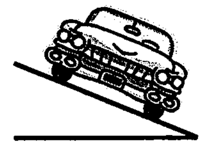


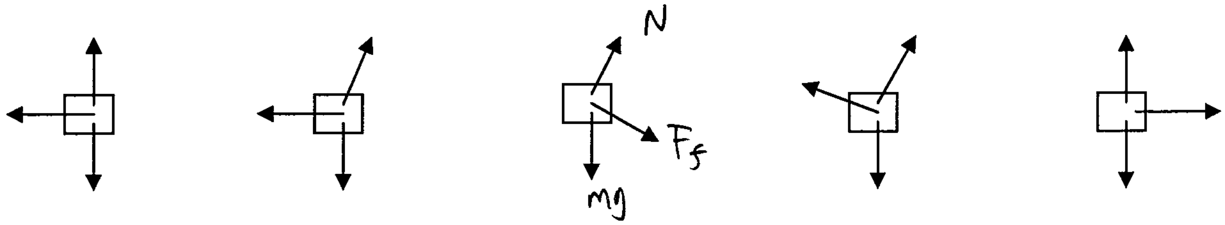
- ☐ zero
- ☐ *mg*, down
- ☐ *mg*, up
- ☒ 2*mg*, down
- ☐ 2*mg*, up

$-F_{mp} = +F_{pm}$
$= mg$

$\Sigma F = F_{pm} + mg = mg + mg$
$= 2mg$

4. A car is turning on a banked corner as shown in the diagram to the right. The speed of the car is very fast so that the car can just barely turn without sliding. The curve of the road has its center to the right of the car. Which diagram below shows the correct free body diagram for this car?





☐ ☐ ☒ ☐ ☐

5. The magnitude of the acceleration due to gravity on the surface of Mars is about 0.378 that on the surface of Earth. The mass of Mars is about 0.107 the mass of Earth. How large is the radius of Mars compared with Earth?

- [ ] 0.080 that of Earth
- [ ] 0.28 that of Earth
- [ ] 0.75 that of Earth
- [ ] 0.20 that of Earth
- [x] 0.53 that of Earth

$\frac{GMm}{r^2} = mg$ $\quad r = \sqrt{\frac{GM}{g}}$

$\frac{r_m}{r_e} = \frac{\sqrt{\frac{GM_m}{g_m}}}{\sqrt{\frac{GM_e}{g_e}}} = \frac{M_m g_e}{M_e g_m} = \sqrt{\frac{.107}{.378}} = .53$

6. A simple harmonic oscillator has a period given by T and oscillates according to the equation $x = A \sin(\omega t)$. At what time (t) during the oscillation will the amplitude be half of the maximum amplitude?

- [ ] 0
- [ ] $T/10$
- [ ] $T/4$
- [x] $T/12$
- [ ] $T/8$
- [ ] $T/2$

$\omega = 2\pi\nu = \frac{2\pi}{T}$

$\frac{A}{2} = A \sin\left(\frac{2\pi}{T}t\right)$

$\frac{2\pi}{T}t = \sin^{-1}\frac{1}{2} = \frac{\pi}{6}$

$t = \frac{1}{12}T$

7. The period of a simple pendulum on earth is 1 second. What will be the period of this pendulum if it is taken to the moon which has an acceleration due to gravity of 1/6 that on earth?

- [ ] 1 s
- [ ] 1/6 s
- [ ] 6 s
- [ ] $1/\sqrt{6}$ s
- [x] $\sqrt{6}$ s
- [ ] 36 s

$T \propto \sqrt{\frac{L}{g}}$

when $g \to \frac{1}{6}g$

$T \to \sqrt{6}\cdot T$

8. A distant planet orbits a star in a circular orbit at a distance of 1/3 the distance between the Sun and the Earth. If the star in question has a mass that is 3 times larger than the Sun, then the length of a year on the distant planet is equal to

- ☐ 3
- ☒ 1/9
- ☐ 1/81
- ☐ 1/3
- ☐ 1/27

times a year on Earth.

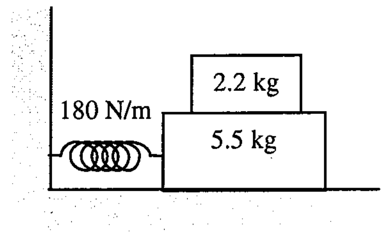
$$\Sigma F = ma_c = \frac{mv^2}{R} = \frac{m}{R}\left(\frac{2\pi R}{T}\right)^2 = \frac{4\pi^2 R m}{T^2}$$

$$\frac{GMm}{R^2} = \frac{4\pi^2 R m}{T^2}$$

$$T = \sqrt{\frac{4\pi^2 R^3}{GM}}$$

$$\frac{T_p}{T_E} = \sqrt{\frac{\frac{4\pi^2 R_p^3}{G M_p}}{\frac{4\pi^2 R_e^3}{G M_e}}} = \sqrt{\frac{R_p^3 M_e}{M_p R_e}} = \sqrt{\left(\frac{1}{3}\right)^3 \frac{1}{3}} = \sqrt{\frac{1}{81}} = \frac{1}{9}$$

9. A block with a mass of 5.5 kg is attached to a spring with a spring constant of 180 N/m. Another block with a mass of 2.2 kg is placed on top of the first block (as shown in the figure to the right). The surface below the bottom block has no friction. The coefficient of static friction between the two blocks is 0.35. What is the maximum amplitude that the system of blocks can oscillate with simple harmonic motion so that the two blocks do not slip with respect to each other?



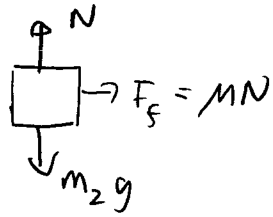
$m_1 = 5.5\ kg \qquad m_2 = 2.2\ kg \qquad M = m_1 + m_2 = 7.7\ kg$

For oscillation $\quad x = A\cos\omega t$

$$\frac{d^2x}{dt^2} = a = -A\omega^2\cos\omega t \Rightarrow a_{max} = A\omega^2$$

$$a_{max} = A\frac{k}{M}$$

For top block:



$$\Sigma F_y = 0 \Rightarrow m_2 g = N$$

$$\Sigma F_x = m_2 a$$

$$\mu N = m_2 a_{max}$$

$$\mu m_2 g = m_2 a_{max}$$

$$\mu g = a_{max} = A\frac{k}{M}$$

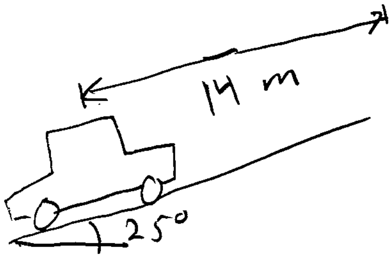
$$A = \frac{M\mu g}{k} = \frac{(7.7\ kg)(.35)(9.8\ m/s^2)}{180\ N/m} = .15\ m = \boxed{15\ cm}$$

10. Problem: While visiting a friend in San Francisco you decide to drive around the city. You are driving up a steep hill when, suddenly, a small boy runs out on the street chasing a ball. You slam on the brakes and skid to a stop leaving a 14 m long skid mark on the street. The boy calmly walks away. You are still shaken when a policeman watching from the sidewalk gives you at ticket for speeding, and points out that the speed limit on this street is 25 mph (11 m/s). After you recover your wits, you examine the situation more closely. You determine that street makes an angle of 25° with the horizontal and that the coefficient of kinetic friction between your tires and the street is 0.60. Your car (with you in it) has a mass of about 1600 kg. Determine your speed before braking and decide whether or not you should fight the ticket?

(You must solve this problem using the Context-Rich Problem work sheets starting on the next page. Partial credit will be given on this problem for steps performed correctly. For this problem, once a significant mistake is made no more credit will be given for any part of the problem, even if it is done correctly.)

FOCUS the PROBLEM

Draw a Picture Using ALL Given Information



μ : .60

m : 1600 kg

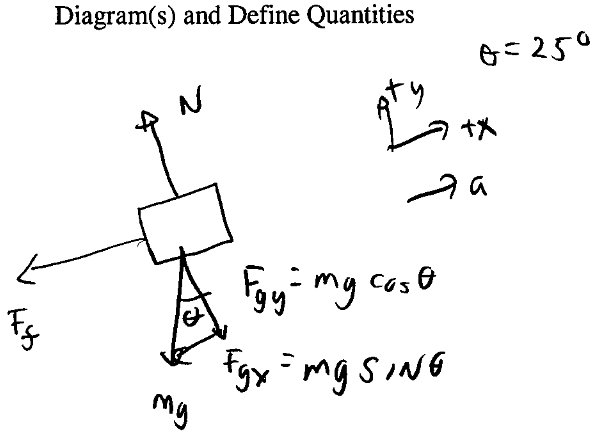
V_{max} = 11 m/s

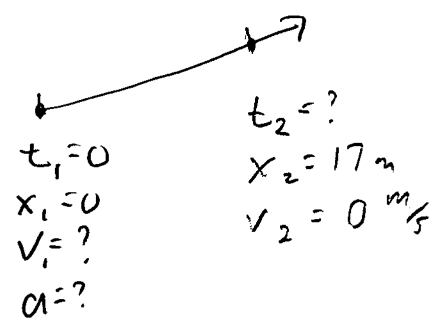
Questions(s) what was my initial speed?

Approach Use kinematic equations to find initial speed with final speed = 0. Use Newton's 2nd law to find acceleration

DESCRIBE the PHYSICS

Diagram(s) and Define Quantities





Target Quantity(ies) $\boxed{V_1}$

Quantitative Relationships

$V_2^2 = V_1^2 + 2a(x_2 - x_1)$ $\quad \Sigma\vec{F} = m\vec{a}$ $\quad F_f = \mu N$

PLAN the SOLUTION

Construct Specific Equations (Same Number as Unknowns)

Find V_1:

$V_2^2 = V_1^2 + 2a(x_2 - x_1)$

(1) $V_1 = \sqrt{-2ax_2}$ $\boxed{x_2, a}$

Find a:

$\Sigma F_x = ma$

$-F_f - mg\sin\theta = ma$

(2) $-\mu N - mg\sin\theta = ma$ $\boxed{N}$

Find N:

$\Sigma F_y = 0$

$N - mg\cos\theta = 0$

(3) $N = mg\cos\theta$

plug (3) in (2)

$-\mu mg\cos\theta - mg\sin\theta = ma$

(A) $a = -g(\mu\cos\theta + \sin\theta)$

Plug (A) in (1)

$V_1 = \sqrt{2g(\mu\cos\theta + \sin\theta)x_2}$

Check Units

$\left[\frac{L}{T}\right] = \sqrt{\frac{[L]}{[T]^2}[L]} = \frac{(L)}{(T)}$ ok

EXECUTE the PLAN

Calculate Target Quantity(ies)

$V_1 = \left(2(9.8\,m/s^2)(.60\cos 25° + \sin 25°)(14\,m)\right)^{1/2}$

$= 16\,m/s$

EVALUATE the ANSWER

Is Answer Properly Stated?

Yes in m/s

Is Answer Unreasonable?

No it is about 37 mph

Is Answer Complete?

No, I was speeding.
I won't fight the ticket

(extra space if needed)