PHYS 201 12:30 Test #2 Fall 2014 Name: Key

A. For the MC questions write your answers in the line next to the question number.

b 1. Which one of the following statements correctly states Newton's first law motion?
a. Every particle in the universe exerts an attractive force on every other particle
b. An object will remain in a state of rest or of uniform motion in a straight line unless acted on by an outside net force.
c. The net force acting on an object is equals to the product of the mass of the object and the acceleration of the object.
d. When one object exerts a force on a second object, the second object exerts a force on the first that has an equal magnitude but opposite direction.
e. Frictional forces are in the opposite direction of motion.

d 2. Which one of the following is also the unit watt, W?
a. $kg.m^2/s^2$ b. $kg/(m.s^2)$ c. $kg.m/s^2$ d. $kg.m^2/s^3$ e. $kg.m/s^3$ f. kg.m/s

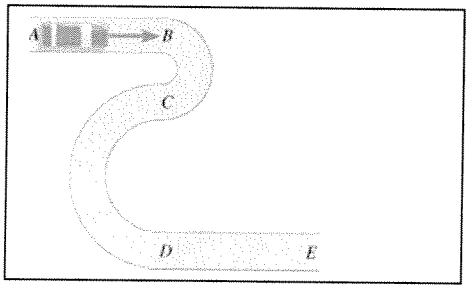
f 3. Which one of the following is a non-contact force?

a. pushing	b. static frictional force	c. Tension
d. kinetic frictional force	e. normal force	f. gravitational force

d 4. Two identical cars have the same speed, one traveling east and one traveling west. Which one of the following is true?
a. Both have the same momentum and same kinetic energy.
b. Both have the same momentum, but different kinetic energy.
c. Both have different momentum and different kinetic energy.
d. Both have the different momentum, but same kinetic energy.

b 5. A car is traveling at a constant speed along the road *ABCDE* shown in the drawing. Sections *AB* and *DE* are straight. In which section of the road, the acceleration is the largest?

a. AB b. BC
c. CD d. DE
e. zero everywhere



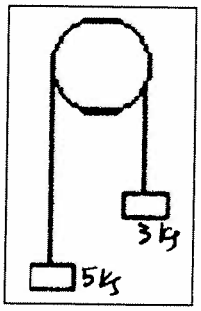
a 6. Which one of the following is an example for a conservative force?
a. electric force b. frictional force c. pushing
d. pulling e. tension in a cord

C 7. What is the centripetal force for a car moving around a flat-curve?
a. Normal force b. Kinetic frictional force
c. Static frictional force d. Weight

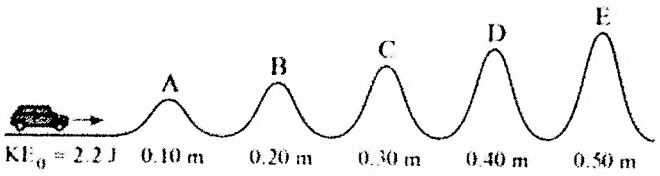
a 8. Two masses (3-kg and 5-kg) are attached by a massless cord passing over a massless, frictionless pulley of an Atwood's machine and released. What will be the acceleration of the masses?

a. 2.45 m/s^2 b. 9.8 m/s^2
c. 3.92 m/s^2 d. 6.53 m/s^2

$a = \frac{\Sigma F}{m} = \frac{(5-3)\times 9.8}{8}$



d 9. A toy car (0.50 kg) runs on a frictionless track and has an initial kinetic energy of 2.2 J, as the drawing shows. The numbers beneath each hill give the heights of the hills. Over which of the hills will the car coast?



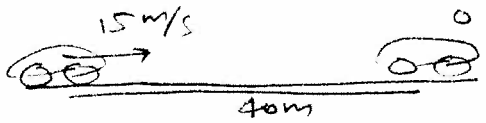
a. A
b. A and B
c. A, B, and C
d. A, B, C, and D
e. A, B, C, D, and E

$KE = mgh$
$2.2 = 0.5 \times 9.8 \times h$
$0.45_m = h$

C 10. Which one of the following terms is used to indicate the natural tendency of an object to remain at rest or in motion at a constant speed along a straight line?
a. Velocity b. Speed c. Inertia d. Force e. Acceleration

End of MC questions

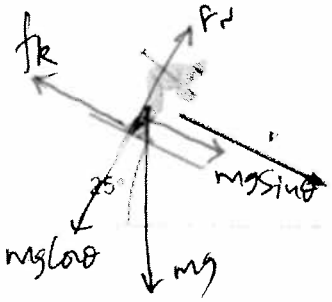
B. 2000-kg car is traveling with a speed of 15 m/s. What is the magnitude of the horizontal net force that is required to bring the car to a halt in a distance of 40 m?



$V_0 = 15$ m/s
$v = 0$
$x = 40$m
$v^2 = v_0^2 + 2ax$
$0 = 15^2 + 2 \times a \times 40$
$a = -2.8125$ m/s^2

$\Sigma F = ma$
$= 2000 \times (-2.8125)$
$= -5625$ N
$|\Sigma F| = 5625$ N

C. A skier is coasting down a 25° slope, at a constant velocity as shown below.
1. Draw a free-body diagram for the skier, naming all the forces.
2. Determine the coefficient of kinetic friction between the skis and slope.



Constant velocity $\rightarrow a = 0$

$\Sigma \vec{F} = m\vec{a} \searrow \quad mg\sin\theta = f_k$

$\Sigma \vec{F} = m\vec{a} \nearrow \quad F_N - mg\cos\theta = 0$

$F_N = mg\cos\theta$

$\mu_k = \frac{f_k}{F_N} = \frac{mg\sin\theta}{mg\cos\theta} = \tan\theta$
$= \tan 25^\circ = 0.466$

$\mu_k = 0.47$

D. Newton's law of gravitation is given: $F = G\frac{m_1 m_2}{r^2}; G = 6.673\times10^{-11}(SI)$.

1. Express the SI unit of the gravitational constant, G. $\frac{Nm^2/kg^2}{} = \frac{kg\cdot\frac{m}{s^2}\cdot\frac{m^2}{kg^2}}{} = \frac{m^3}{kg\cdot s^2}$

2. In another solar system a planet has twice the earth's mass and half the earth's radius. Your weight on this planet is __8__ times your earth-weight. Assume that the masses of the earth and the other planet are uniformly distributed.

$$W = \frac{G2m_1m_2}{(\frac{r}{2})^2} = 8\frac{Gm_1m_2}{r^2}$$

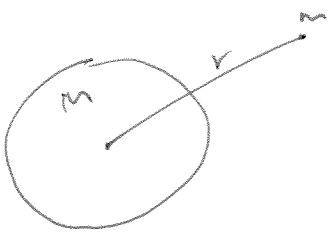
3. An expression for the magnitude of the centripetal force, F_c in terms of the mass (m) and speed (v) of the object and the radius (r) of the circular path is given below. Show that the following equation is correct unit wise.

$F_C = m\frac{v^2}{r}$.

$$F_C = \frac{mv^2}{r}$$

$$= \frac{kg\cdot m^2/s^2}{m} = kg\cdot m/s^2 = N \checkmark$$

4. Derive an expression for the speed of a satellite (v) in circular orbit around Earth in terms of the universal gravitational constant (G), mass of Earth (M), and the distance of the satellite from the center of Earth (r).



$$\frac{mv^2}{r} = \frac{GMm}{r^2}$$

$$v^2 = \frac{GM}{r}$$

$$v = \sqrt{\frac{GM}{r}}$$

5. A satellite circles the Earth in an orbit whose altitude is equal to the radius of the Earth. Calculate the speed of the satellite.
(Mass of Earth = M = 5.98 x 10^{24}Kg, Radius of Earth = R = 6380 km)

$$v = \sqrt{\frac{GM}{r}}; \quad r = R+R = 2\times6.38\times10^6$$

$$v = \sqrt{\frac{6.673\times10^{-11}\times5.98\times10^{24}}{2\times6.38\times10^6}}$$

$$\boxed{v = 5592\ m/s}$$

E. A basketball (m = 0.60 kg) is dropped from rest. Just before striking the floor, the ball has a momentum whose magnitude is 3.3 kg·m/s. At what height was the basketball dropped?

$p = mv = 3.3\ kg \cdot m/s$

$v = \frac{3.3}{.6} = 5.5\ m/s$

PE

h

KE

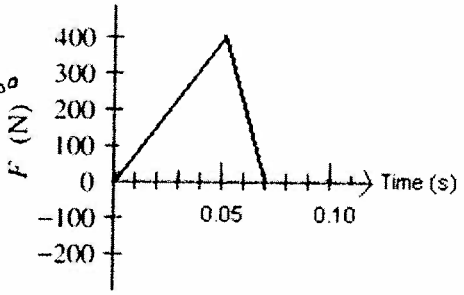
$mgh = \frac{1}{2}mv^2$

$h = \frac{v^2}{2g} = \frac{5.5^2}{2(9.8)}$

$\boxed{h = 1.54\ m}$

F. The force applied to a tennis ball (mass = 0.06 kg) during a serve is shown below as a function of time.

a. Determine the impulse applied to the ball.
b. What is the magnitude of the velocity after the serve?



a. Impulse = area of F vs time

$= \frac{1}{2} \times b \times h = \frac{1}{2} \times 0.07 \times 400$

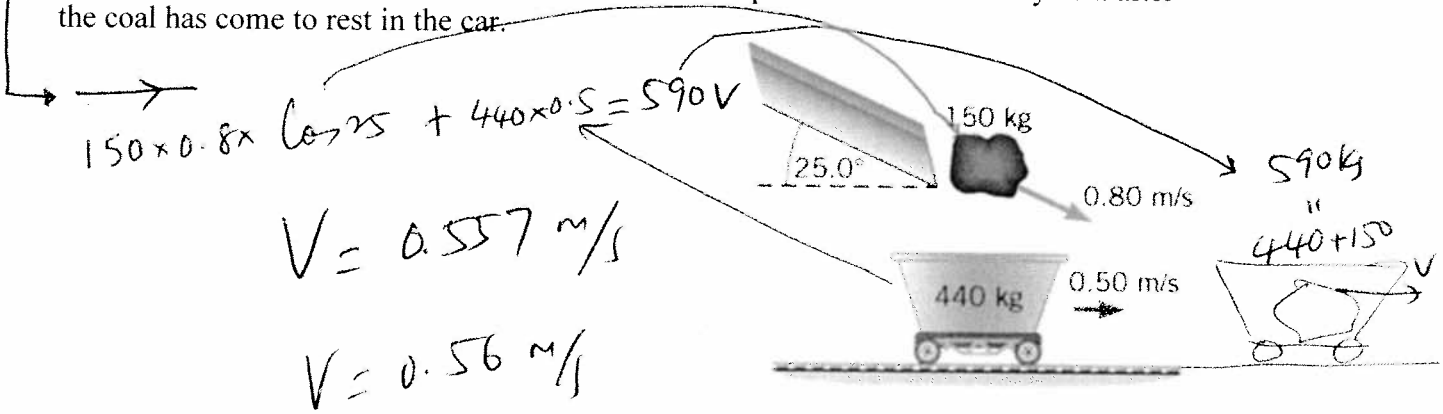
$= 14\ N \cdot s$

b. Impulse $= mv_f - mv_i$

$14 = 0.06 v_f - 0$

$v_f = \frac{14}{0.06} = 233\ m/s$

G. A mine car (mass = 440 kg) rolls at a speed of 0.50 m / s on a horizontal track, as the drawing shows. A 150-kg chunk of coal has a speed of 0.80 m / s when it leaves the chute. Using the conservation of momentum, determine the speed of the car–coal system after the coal has come to rest in the car.



$150 \times 0.8 \times \cos 25 + 440 \times 0.5 = 590V$

$V = 0.557\ m/s$

$V = 0.56\ m/s$