PHYS 101H Summer-R 2016 Test #2

You may tear this sheet and use it as your work sheet.

	MOTION	
	Linear	Rotational
Time interval	t	t
Displacement	d; (d = rθ)	θ
Velocity	v = d/t; (v = rω)	ω = θ/t
Acceleration	a = Δv/t; (a = rα)	α = Δω/t
Kinematic equations	$v = v_0 + at$	$\omega = \omega_0 + \alpha t$
	$v^2 = v_0^2 + 2ad$	$\omega^2 = \omega_0^2 + 2\alpha\theta$
	$d = v_0 t + \frac{1}{2} at^2$	$\theta = \omega_0 t + \frac{1}{2} \alpha t^2$
	$d = \frac{1}{2}(v + v_0)t$	$\theta = \frac{1}{2}(\omega + \omega_0)t$
To create	force = F	torque = F·L
Inertia	Mass =m	Rotational inertia = $I = mr^2$
Newton's 2nd Law	$F_{net} = ma$	$\tau_{net} = I\alpha$
Momentum	$\mathbf{p} = m \cdot \mathbf{V}$	$\mathbf{L} = I \cdot \omega$
Conservation of momentum	$\Sigma m_i v_i = \Sigma m_f v_f$	$\Sigma I_i \omega_i = \Sigma I_f \omega_f$
Kinetic Energy	Translational Kinetic Energy = TKE = $\frac{1}{2} mv^2$	Rotational Kinetic Energy = RKE = $\frac{1}{2} I\omega^2$
Work	W=F·d	W=τ·θ
Impulse	J = F·t = mv - mv_0	

Force of friction: $F_{fr} = \mu F_N$. Acceleration due to gravity = g = 9.8 m/s^2.

Newton's law of gravitation is given by: $F = G\frac{m_1 m_2}{r^2}; G = 6.673 \times 10^{-11} (SI)$.

Centripetal force is given by, $F_c = m\frac{v^2}{r}$. Potential Energy is given by, $PE = mgh$.

Work done by a Force, $W = F \times d$. Power = Work/Time.

Area of a triangle = $\frac{1}{2} \times base \times height$.

PHYS 101H Test #2 Summer 2016 Name: KEY

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

C 1. Which one of the following is Newton's first law motion?
e 2. Which one of the following is Newton's third law motion?
b 3. Which one of the following is Newton's law of universal gravitation?

Answers for 1-3

a. Every particle in the universe exerts a repulsive force on every other particle
b. Every particle in the universe exerts an attractive force on every other particle
c. 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.
d. The net force acting on an object is equals to the product of the mass of the object and the acceleration of the object.
e. 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.
f. Frictional forces are in the opposite direction of motion.

c 4. Which one of the following is also the unit newton, N?
a 5. Which one of the following is also the unit joule, J?
d 6. Which one of the following is also the unit watt, W?
f 7. Which one of the following is a unit for impulse?

Answers for 4-7

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 8. 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 9. 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.

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?

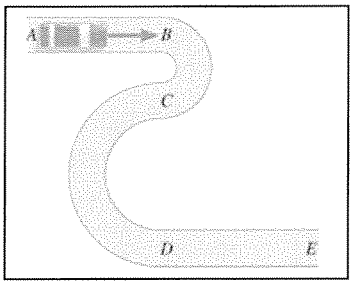
a. Velocity b. Speed c. Inertia d. Force e. Acceleration

c 11. What is the centripetal force for a car moving around a flat-curve?
e 12. What is the centripetal force for a satellite in orbit around a planet?

Answers for 11-12

a. Normal force b. Kinetic frictional force
c. Static frictional force d. Weight e. Gravitational force

13-14) A car is traveling at a constant speed along the road *ABCDE* shown in the drawing. Sections *AB* and *DE* are straight.



b 13. In which section of the road, the acceleration is the largest?
a. AB b. BC c. CD d. DE

a 14. In which section of the road, the acceleration is zero?
a. AB & DE b. BC & CD
c. CD & DE d. AB & BC

Newton's Law of Universal Gravitation is given by: $F = \frac{Gm_1m_2}{r^2}; G = 6.67\times10^{-11}(SI)$

b 15. Express the SI unit of G.
a. N.kg/m^2 b. N.m^2/kg^2 c. N.m/kg^2 d. N.kg^2/m^2 e. N/kg^2 f. N.m/kg

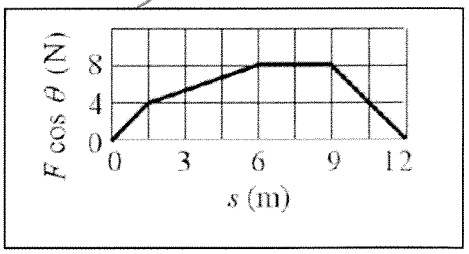
d 16. According to the Law of Universal Gravitation, when the distance between the centers of two objects is doubled and the masses remain constant the force between the objects is multiplied by a factor of:
a. 1 b. 2 c. 4 d. ¼ e. ½

e 17. In another solar system a planet has twice the earth's mass and half the earth's radius. Your weight on this planet is _____ times your earth-weight.
a. 2 b. 3 c. 4 d. 6 e. 8 f. 10

a 18. An engineer is asked to design a playground slide such that the speed a child reaches at the bottom does not exceed 6.0 m/s. Determine the maximum height that the slide can be.
a. 1.8 m b. 2.9 m c. 3.2 m d. 4.5 m e. 7.4 m

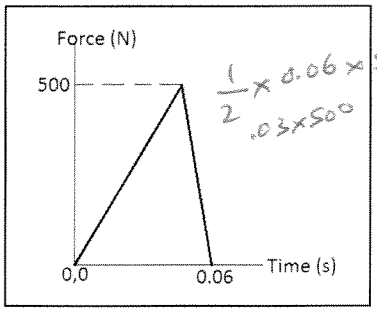
$mgh = \frac{1}{2}mv^2$
$h = \frac{v^2}{2g} = \frac{6^2}{2\times9.8}$

b 19. The force component acting on an object along the displacement varies with the displacement *s* as shown in the graph. Determine the work done on the object as it travels from *s*= 0.0 to 12 m.
a. 81 J b. 66 J c. 72 J
d. 57 J e. 48 J f. 96 J



1 box = 6J
11 box = 66J

c 20. The force applied to a tennis ball (mass = 0.06 kg) during a serve is shown as a function of time. What is the impulse applied to the ball? a. 5 N.s b. 10 N.s c. 15 N.s d. 30 N.s



$\frac{1}{2}\times0.06\times500$
$.03\times500$

e 21. What is the angular speed in rad/s of the hour hand of an analog watch?
a. 1.75 x 10^{-3} b. 0.105 c. 8.33 x 10^{-3}
d. 8.73 x 10^{-3} e. 1.45 x 10^{-4}

$\frac{2\pi}{12\times3600}$

a 22. During a spin dry cycle of a washing machine, the motor speeds from 30 rad/s to 95 rad/s while turning the drum through an angle of 402 radians. How long it took to spin this angle? a. 6.43 s b. 3.21 s c. 4.23 s d. 13.4 s e. 62.5 s

$\omega_0 = 30$ rad/s, $\omega = 95$ rad/s, $\theta = 402$ rad

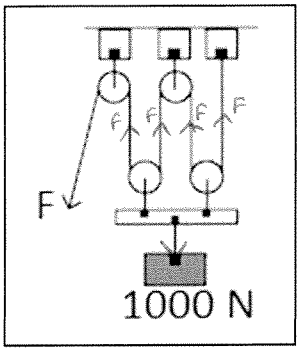
$\theta = \frac{1}{2}(\omega_0+\omega)t \rightarrow t = \frac{2\theta}{\omega_0+\omega} = \frac{2\times402}{(30+95)} = 6.43$ sec

C 23. An object weighing 1000-N is lifted as shown using a frictionless pulley system. What minimum F is necessary to lift the object?

a. 1000-N b. 500-N c. 250-N
d. 200-N e. 100-N

$4F = 1000$

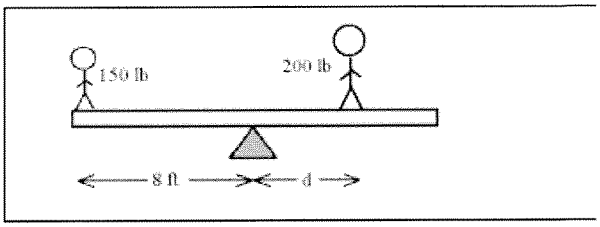
$F = 250$



b 24. A seesaw is pivoted in the center. At what distance from the center would a 200 lb person sit to balance a 150 lb person on the opposite end?

a. 8 ft b. 6 ft c. 4 ft d. 2 ft

$\frac{150 \times 8}{200}$



C 25. Which one of the following energy transformation takes place during photosynthesis?

a. Radiant energy is converted into electrical energy
b. Electrical energy is converted into mechanical energy
c. Radiant energy is converted into chemical energy
d. Mechanical energy is converted into thermal energy
e. Chemical energy is converted into radiant energy

d 26. Which one of the following energy transformation takes place in a microphone?

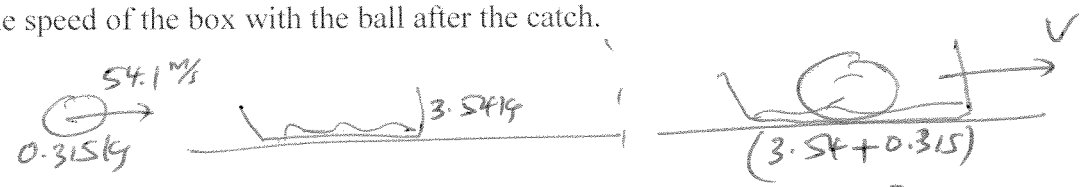
a. Radiant energy is converted into electrical energy
b. Electrical energy is converted into mechanical energy
c. Radiant energy is converted into thermal energy
d. Mechanical energy is converted into electrical energy
e. Electrical energy is converted into radiant energy

B1. State the law of conservation of momentum.

In the absence of external net force, the total momentum of an isolated system, stays the same.

B2. A physics student hurls a 315-gram ball directly into a 3.54-kg box which is at rest on a table top. The baseball strikes the box with a pre-impact speed of 54.1 m/s. The box is filled with towels to help *absorb the blow* and effectively *catch* the ball.

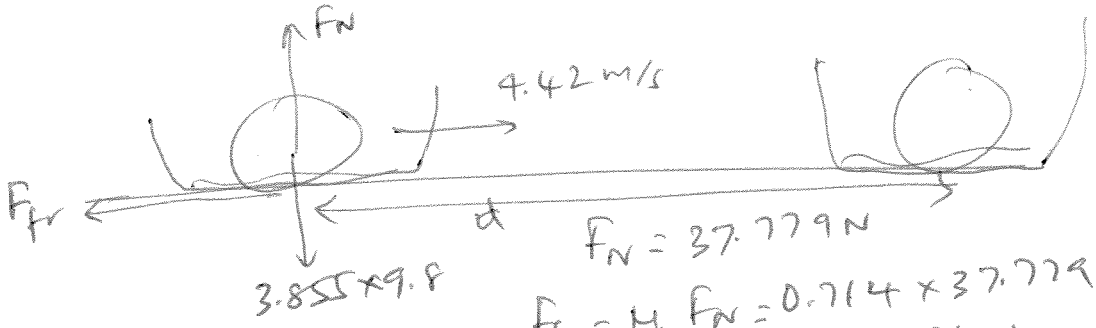
a. Find the speed of the box with the ball after the catch.



$0.315 \times 54.1 = (3.54+0.315)V$

$V = \frac{0.315 \times 54.1}{3.855} = 4.42 \text{ m/s}$

b. The coefficient of friction between the box and the table is 0.714. Determine the distance which the ball and box slide across the table after the collision.



$f_{fr} = \mu_k F_N = 0.714 \times 37.779$

$= 26.974 \text{ N}$

$a = -\frac{26.974}{3.855} = -7 \text{ m/s}^2$

$V_0 = 4.42 \text{ m/s}, \quad V = 0$

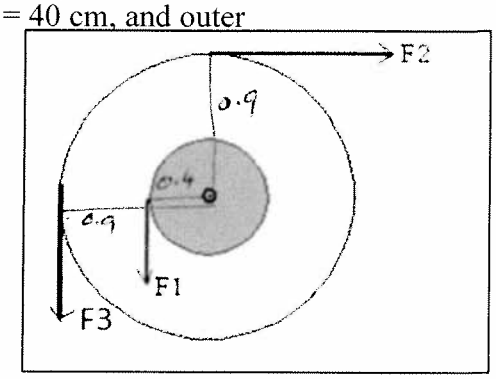
$V^2 = V_0^2 + 2ad$

$0 = 4.42^2 - 2 \times 7 \times d$

$14d = 4.42^2$

$d = \frac{4.42^2}{14} = 1.4 \text{ m}$

C. Refer to the wheel system shown below. Its axis is at the center, perpendicular to the page. Assume F1 = 50-N, F2 = 70-N, and F3 = 60-N. Inner radius = 40 cm, and outer radius = 90 cm.



a. What is the torque (magnitude and direction) exerted by F_1?

$50 \times 0.4 = 20\ N \cdot m$ CCW

b. What is the torque (magnitude and direction) exerted by F_2?

$70 \times 0.9 = 63\ N \cdot m$ CW

c. What is the torque (magnitude and direction) exerted by F_3?

$60 \times 0.9 = 54\ N \cdot m$ CCW

d. What is the net torque (magnitude and direction) acting on the wheel system?

$20 + 54 - 63 = 11\ N \cdot m$

$11\ N \cdot m$ CCW $= +11\ N \cdot m$

D. List a contribution (full sentence) to science by each one of the following:

a. Aristotle: Believed that a heavy object would fall more quickly than a lighter object.

b. Galileo: Argued that no force is required to maintain motion.

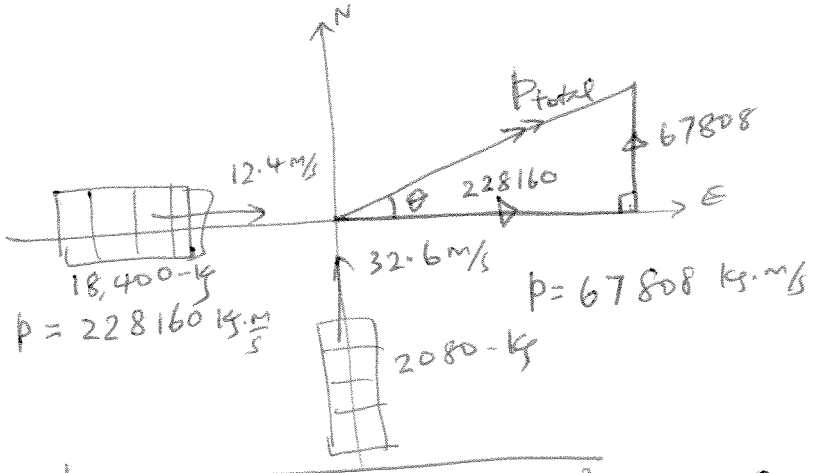
c. Newton: Published principia, the Laws of Motion & the Law of universal gravitation.

d. Einstein: Developed the theory of relativity.

E. The city police are in pursuit of Robin Banks after his recent holdup at the savings and loan. The high speed police chase ends at an intersection as a 2080-kg Ford Explorer (driven by Robin) traveling north at 32.6 m/s collides with a 18400-kg garbage truck moving east at 12.4 m/s. The Explorer and the garbage truck entangle together in the middle of the intersection and move as a single object.

a. Determine the post-collision speed and direction of the two entangled vehicles.

b. Calculate the energy loss during this collision.



$$p_{total} = \sqrt{67808^2 + 228160^2} = 238023$$

$$v_{total} = \frac{p_{total}}{M_{total}} = \frac{238023}{(18,400+2080)} = 11.62\ m/s$$

$$\tan\theta = \frac{67808}{228160} = 0.297 \longrightarrow \theta = 16.5^\circ$$

KE before Collision $= \frac{1}{2} \times 18400 \times 12.4^2 + \frac{1}{2} \times 2080 \times 32.6^2$

$= 1414592 + 1105270$

$= 2519862\ J = 2.52\ MJ$

KE after Collision $= \frac{1}{2} M_{total} v_{total}^2$

$= \frac{1}{2} \times (18,400+2080) \times 11.62^2$

$= 1382649 = 1.38\ MJ$

Loss $= (2.52 - 1.38)\ MJ = 1.14\ MJ$

$= 1.14 \times 10^6\ J$