NAME SOLUTIONS

BOX NUMBER ———

EXAM 1

PHYSICS 1310
MARCH 10, 2022

80 POINTS + 10 POINTS OF EXTRA CREDIT POSSIBLE

CIRCLE ANSWER OR ANSWERS TO EACH QUESTION

UNLESS NOTED OTHERWISE IN PROBLEM DESCRIPTION, NO CREDIT WILL BE GIVEN WITHOUT AN APPROPRIATE EXPLANATION (TEXT AND/OR EQUATIONS) SUPPORTING EACH CORRECT ANSWER

PARTIAL CREDIT POSSIBLE FOR WORK SHOWN

3" X 5" CRIB SHEET OK, NO OTHER NOTES ETC. ALLOWED

NO ELECTRONIC DEVICES OF ANY KIND ALLOWED OR VISIBLE

USE BACK OF PAGE IF ADDITIONAL SPACE IS REQUIRED

1. (10 Points). SI units of energy are (there may be more than one correct answer):
(NO NEED TO SHOW ANY WORK)

A. Joules

B. Newton · meters

C. Newtons

D. $kg \cdot m^2/s^2$

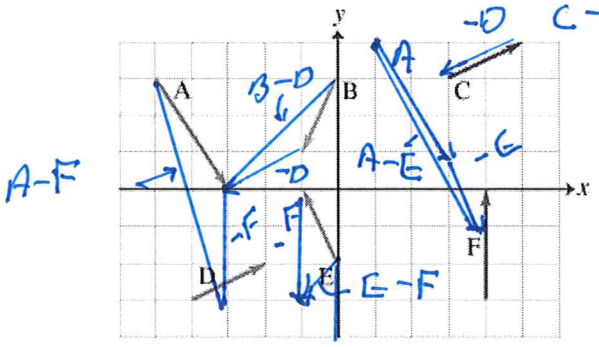
E. $kg \cdot m/s^2$

F. kg·m/s

G. Watts

F. Watt · seconds

2. (10 Points). Referring to the figure on the right, which two vectors when one is subtracted from the other have the largest *magnitude*?



A. A and F

B. A and E

C. D and B

D. C and D

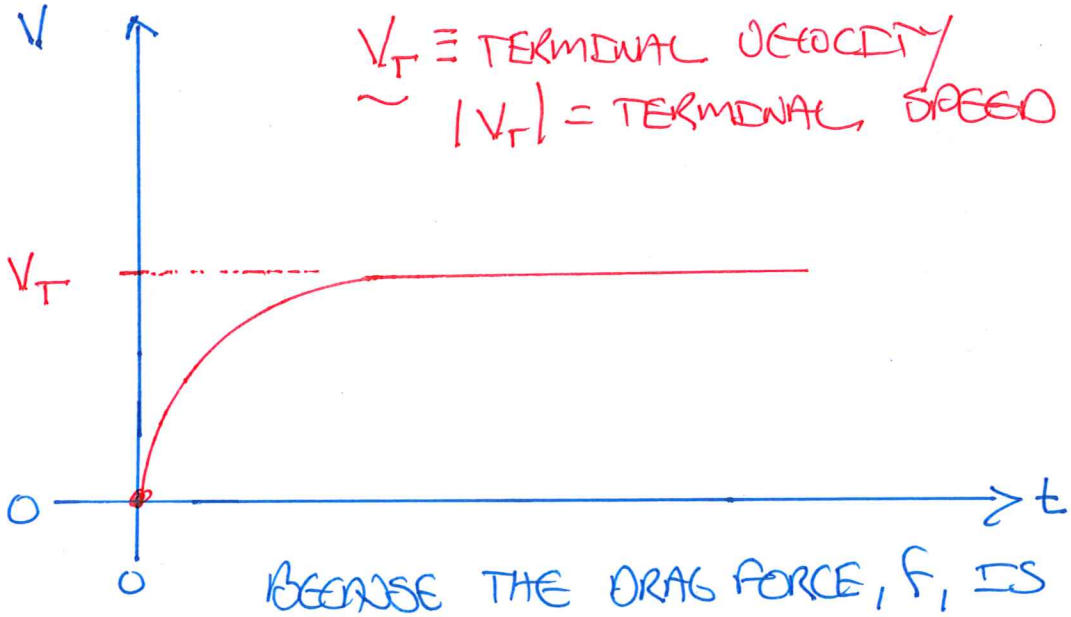
E. E and F

3. (10 Points). Write down Newton's 3rd Law in words.

THERE ARE SEVERAL WAYS TO PHRASE NEWTON'S 3RD LAW. ONE IS:

IF OBJECT 1 EXERTS A FORCE ON OBJECT 2, THEN OBJECT 2 EXERTS AN OPPOSITELY DIRECTED FORCE OF EQUAL MAGNITUDE ON OBJECT 1.

4. (10 Points) An object is dropped from rest near the surface of the Earth. If air resistance ***cannot*** be ignored, qualitatively plot its velocity as a function of time. EXPLAIN THE REASONING BEHIND WHAT YOU DRAW.



$V_T \equiv$ TERMINAL VELOCITY

$\sim |V_T| =$ TERMINAL SPEED

BECAUSE THE DRAG FORCE, F_1 IS $F_- = DV^2$ AND THUS INCREASES WITH THE SPEED OF THE OBJECT. BY NEWTON'S 2ND LAW $F = ma = Dv^2 - mg \to 0$ SO $V_- \to \left(\frac{mg}{D}\right)^{1/2}$ AS $t \to \infty$. TAKE $V_T = \left(\frac{mg}{D}\right)^{1/2}$

5. (10 Points). A foul ball travels straight up and is in the air for T seconds before striking the ground. Take g as the acceleration due to gravity. What was the velocity of the ball when it left the bat? Assume the bat struck the ball at very close to the elevation of the ground. (SHOW WORK)

ACCELERATION DUE TO GRAVITY IS CONSTANT SO WE CAN USE ASSOCIATED KINEMATIC EQUATIONS

$y_f = y_0 + v_i t - \frac{1}{2} g t^2$

$0 = 0 + v_i t - \frac{1}{2} g t^2 \Rightarrow v_i = \frac{1}{2} g t = \frac{1}{2} g T$

A. gT

B. $2gT$

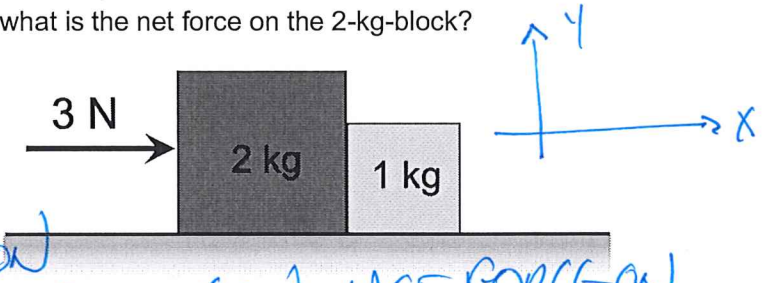
C. $gT/2$

D. $gT^2/2$

E. $gT/4$

F. None of the above, we need to know the ball's mass

6. (10 Points). Referring to the figure to the right, what is the net force on the 2-kg-block? (SHOW WORK)



ALL FORCES IN Y-DIRECTION CANCEL FOR X DIRECTION

BY NEWTON'S 2ND CAN NET FORCE ON BLOCKS IS $F_{NET} = Ma = (m_1 + m_2)a = 3N$

$\Rightarrow a = \frac{F_{NET}}{m_1 + m_2} = \frac{3N}{2Kg + 1Kg} = 1 \frac{m}{s^2}$

SO NET FORCE ON 2Kg BLOCK IS

$F_{2Kg} = m_{BLOCK}\, a = 2Kg \cdot 1 \frac{m}{s^2} = 2N$

A. 1 N

B. 2 N

C. 3 N

D. 3/2 N

E. 2/3 N

F. 1/3 N

7. (10 Points) What is the centripetal acceleration required to keep an object on the Earth at its equator? You may use any of these variables as necessary: R = radius of earth; T = period of rotation of the earth; g = gravitational acceleration near the surface of the earth, M = mass of the earth, m = mass of object. (SHOW WORK)

$a = \frac{v^2}{R} = \frac{1}{R}\left(\frac{2\pi R}{T}\right)^2 = \left(\frac{2\pi}{T}\right)^2 R$

TANGENTIAL SPEED AT EQUATOR

A. g

B. $2g$

C. $-mg$

D. Mg

E. $(2\pi/T)^2R$

F. R/T^2

F. Zero

8. (10 Points) Use work and kinetic energy considerations to find the minimum stopping distance for a car of mass m with anti-lock brakes traveling with an initial speed of v? Take g as the acceleration due to gravity and μ_s as the coefficient of static friction between the road and the car's tires. (SHOW WORK)

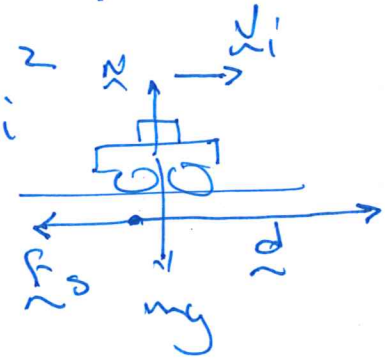
BY THE WORK ENERGY THEOREM

$W = \Delta KE$

$f_s d \cos\pi = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$-1 \qquad 0$

$-f_s d = -\frac{1}{2}mv_i^2$



$(\mu_s mg)d = \frac{1}{2}mv_i^2$

$\therefore d = \frac{v_i^2}{2\mu_s g} = \boxed{\frac{v^2}{2\mu_s g}}$

EXTRA CREDIT. (10 Points) Two objects have the same translational kinetic energy. If one object is more massive than the other, which has the greatest momentum? JUSTIFY YOUR ANSWER.

$KE_1 = \frac{1}{2} m_1 v_1^2 = KE_2 = \frac{1}{2} m_2 v_2^2 \equiv KE.$

$KE = \frac{p_1^2}{2m_1} = \frac{p_2^2}{2m_2}$

$\therefore \quad p_1 = (2m_1 KE)^{1/2} \qquad p_2 = (2m_2 KE)^{1/2}$

SO IF $m_1 > m_2$ $p_1 > p_2$ AND VICE-VERSA.