EXAM 2 PH111 3/8/19 Strong/Chronis KEY '19

REMOVE THE EQUATION SHEET BEFORE YOU START

EQUATIONS:

$\sum \vec{F} = m\vec{a}$

$f_s = \mu_s N$ and $f_k = \mu_k N$

$F_{spring} = -kx$

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

$Work = \Delta K = -\Delta U = \vec{F} \cdot \vec{d} \rightarrow \int_{x_o}^{x_f} F(x)\, dx$

$W_{spring} = -\frac{k}{2}\left(x_f^2 - x_i^2\right)$

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

$U = mgh$ or $\frac{1}{2}kx^2$

$E = K + U$

$\Delta E = \Delta K + \Delta U = -f_k d$

$P = \vec{F} \cdot \vec{v} = \frac{dW}{dt}$

$v_t = \sqrt{\frac{2mg}{C\rho A}}$

EXAM 2, PH111 3/8/19 STRONG/CHRONIS

NAME KEY '19

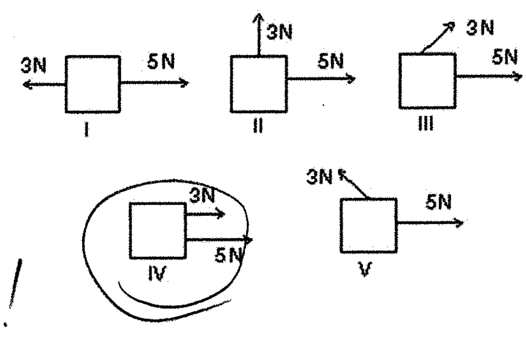
Please print your name as it appears in my class roster.

Exam Instructions:

1. Circle one answer for each problem.
2. Enter your answer using your clicker.
3. Since the problems have imbedded partial credit, you should not leave any problems blank either on your paper or on your clicker!
4. Turn in exam and all scratch paper used during exam.

1. Two forces, one with a magnitude of 3 N and the other with 5 N, are applied to an object. For which orientation of the forces shown in the diagrams below will the magnitude of the acceleration be the **most**?

least 2 *A.* I
B. II
C. III
D. IV
E. V



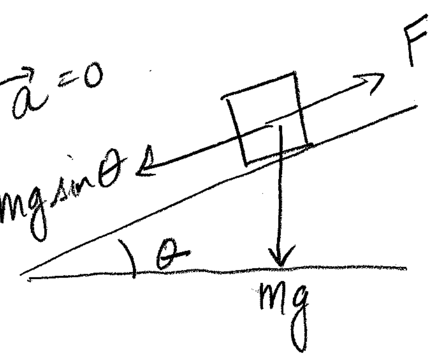
Forces add!

2. A force, ***F***, parallel to the incline, is required to push a certain crate at constant velocity up a frictionless incline that is an angle of $\boldsymbol{\theta}$ above the horizontal. The mass of the crate is given by:

A. $F/(g \sin\theta)$
3 **B.** $F/(g \cos\theta)$
C. g
D. F
2 **E.** $Fg/\sin\theta$

$0 = F - mg\sin\theta \quad \vec{a} = 0$

$\Rightarrow m = \dfrac{F}{g\sin\theta}$



3. A penguin slides down a frictionless, icy plane that makes an angle of 20° with the horizontal. The acceleration of the penguin in m/s^2 is:

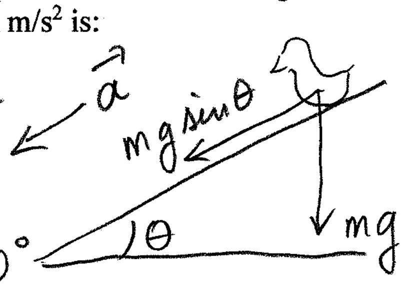
A. Zero
B. 3.4
cosθ 2 *C.* 9.2
D. 4.0
E. 6.1

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

$a = g\sin\theta$

$= (9.8\,m/s^2)\sin 20°$

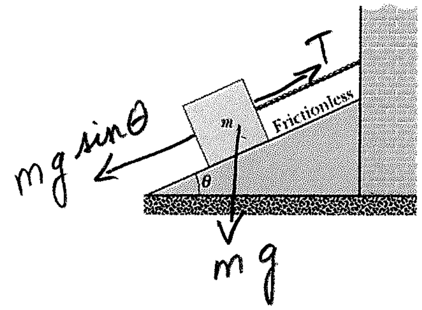
$= 3.35\ m/s^2$



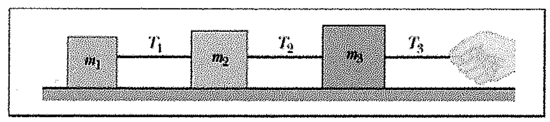
4. In the figure, let the mass of the block be 10 kg and the angle of the incline be 40° above the horizontal. Find the tension in the cord.

$mg\cos\theta$ 2 **A.** 75 N
g? 3 **B.** 6.4 N
C. 12 N
D. 8.1 N
E. 63 N

$$T = mg\sin\theta$$
$$= (10\text{ kg})(9.8\text{ m/s}^2)\sin 40°$$
$$= 63\text{ N}$$



5. In the figure, three connected blocks are pulled to the right on a horizontal frictionless table by a force of magnitude T_3. Assume you are also given the acceleration of the system, a, and the values masses m_2 and m_3. What is the mathematical expression needed to determine the value of m_1?

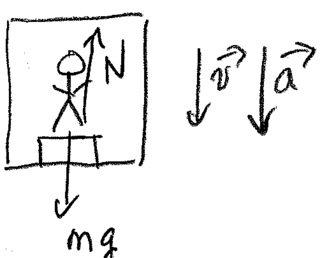


sign 4 **A.** $\frac{T_3}{a} + (m_2 + m_3)$
B. $\frac{(m_2+m_3)}{a}$
C. $\frac{T_3}{a} - (m_2 + m_3)$
2 **D.** $(m_2 + m_3)$
2 **E.** $\frac{T_3}{a}$

$$T_3 = (m_1 + m_2 + m_3)a = (m_2 + m_3)a + m_1 a$$
Then $T_3 - (m_2 + m_3)a = m_1 a$
$$\frac{T_3}{a} - (m_2 + m_3) = m_1$$

6. A man weighing 880 N is standing on a scale in an elevator that is falling and its speed is increasing at 1.5 m/s^2. The reading on the scale is:

A. 350 N
B. 745 N
C. 880 N
sign 4 **D.** 1.0 kN
E. 1.2 kN

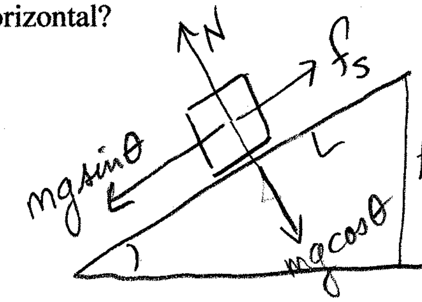


$$mg - N = ma$$
$$\Rightarrow N = mg - ma$$
$$= 880\text{N} - \left(\frac{880\text{N}}{9.8\text{ m/s}^2}\right)(1.5\text{ m/s}^2)$$
$$= 745\text{ N}$$

7. A box rests on a rough board of length L. When one end of the board is slowly raised to a height h above the other end, the box **just** begins to slide. If the coefficient of static friction is $\mu_s = 0.5$, what is the resulting angle of the incline with respect to the horizontal?

A. 27°
cos + sine 2 **B.** 30°
2 **C.** 60°
D. 90°
E. Need more information.

So $mg\sin\theta = \mu_s mg\cos\theta$
$$\mu_s = \tan\theta$$
$$\theta = \tan^{-1}(\mu_s)$$
$$= \tan^{-1}(0.5)$$
$$= \underline{27°}$$



8. Tension in a cable, ***T***, is parallel to an incline of θ above the horizontal and pulls a block up the incline at a constant acceleration of ***a***. Assume there exists a kinetic frictional force, f_k, between the block and the incline. The **mass of the block** is given by:

3 **A.** $\frac{T}{(a+\mu_k g\cos\theta)}$

3 **B.** $\frac{T}{(a+g\sin\theta)}$

2 **C.** $\frac{T}{\mu_k g\cos\theta}$

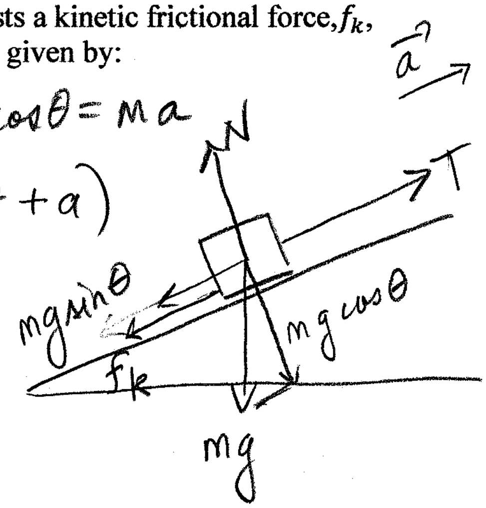
D. $\frac{T}{g}$

E. $\frac{T}{a+g\sin\theta+\mu_k g\cos\theta}$

$T - mg\sin\theta - \mu_k mg\cos\theta = ma$

$T = m(g\sin\theta + \mu_k g\cos\theta + a)$

$\Rightarrow \quad m = \frac{T}{(a + g\sin\theta + \mu_k g\cos\theta)}$



9. Diavolo the Dare Devil rides his bicycle on a loop-the-loop in a circus. The radius of the loop-the-loop is 7.1 meters. What minimum speed must he have so he doesn't fall from the top of the loop? (*Hint: The only force acting at the top of the loop will be that of gravity.*)

√ 3 **A.** 70 m/s
B. 1.2 m/s
C. 5.7 m/s
D. 8.3 m/s
E. 1.4 m/s

$\cancel{m}g = \frac{\cancel{m}v^2}{r}$

$v = \sqrt{gr} = \sqrt{(9.8\,\frac{m}{s^2})(7.1\,m)}$

$= 8.3\ m/s$

10. At what height *h* should a block be released from rest so that it is on the verge of losing contact with the track at the top of the loop? Assume the radius of the loop is 0.25 meters. *(Hint: Yes, this is another Diavolo problem.)*

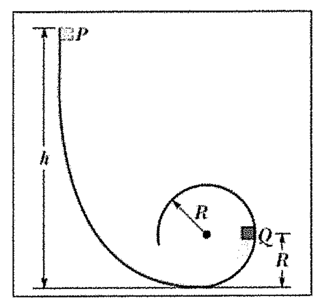
2R 3 **A.** 0.5 m
B. 0.75 m
C. 0.625 m
D. 2.0 m
0.5R 3 **E.** 0.125 m

$\Delta K + \Delta U = 0$

$K_f - \cancel{K_i} + U_f - U_i = 0$

$\frac{1}{2}m(gR) + mg(2R) - mgh = 0$

$h = \frac{R}{2} + 2R = 2.5R = 0.625m$



11. A certain car, going with speed v_1, rounds a level curve with a radius R_1 and is just on the verge of skidding. If the new speed is $3v_1$, what is the radius of the tightest curve on the same road that the car can round without skidding? (*Hint: Friction force equals centripetal force.*)

$(\ )^2$ 3 **A.** $3R_1$
B. $9R_1$
C. $R_1/3$
D. R_1
2 **E.** $R_1/9$

$F_c = \frac{mv^2}{r} \Leftrightarrow f_k$

So: $\frac{m v_1^2}{r_1} = f_k = \frac{m(3v_1)^2}{r_2}$

$\Rightarrow r_2 = 9r_1$

12. A stone of mass m is attached to a string and swung in a circle of radius r on a horizontal and frictionless surface. In terms of the tension force in the string and the radius r, find the time t for the stone to make one revolution. (*Hint: Tension must be the centripetal force.*)

(2) 3 **A.** $\pi\sqrt{mr/T}$

B. mg

$\sqrt{\ }$ + **C.** $4\pi^2 mr/T$

$(2\pi r)$ 2 **D.** $\sqrt{mr/T}$

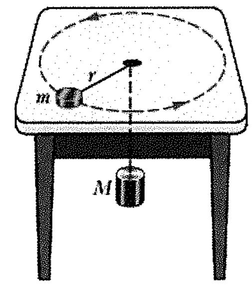
E. $2\pi\sqrt{mr/T}$

$$Mg = T = \frac{mv^2}{r}$$

$$1 \text{ rev} = 2\pi r = \text{distance}$$

$$\sqrt{\frac{rT}{m}} = v = \frac{2\pi r}{t}$$

$$\text{then } t = 2\pi r\sqrt{\frac{m}{rt}} = 2\pi\sqrt{\frac{mr}{T}}$$



13. An escalator motor has a power of 2100 W. It carries people upward a distance of 5m. How many 80-kg people can it carry in one minute? *(Remember that power is the "rate at which work is done.")*

A. 32

B. 0

5m? 3 **C.** 160

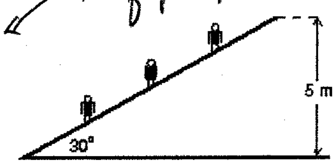
D. 54

E. 21

$$P = 2100\,W = F\cdot d/t \quad \text{\# of people}$$

$$2100W = (mg)(h)/t * N$$

$$N = \frac{(2100W)(60s)}{(80\,kg)(9.8\,m/s^2)(5m)} = 32 \text{ people}$$



14. When a certain rubber band is stretched a distance x, it exerts a restoring force $F = a + bx$, where a and b are constants. The work done in stretching this rubber band from $x = 0$ to $x = L$ is:

4 **A.** $aL + bL^2$

3 **B.** aL

2 **C.** bL^2

D. $aL + bL^2/2$

E. $a + 2bL$

$$W = \vec{F}\cdot\vec{d}$$

$$= \int_0^L (a+bx)\,dx = \left(ax + \frac{bx^2}{2}\right)\Big|_0^L$$

$$= aL + \frac{bL^2}{2}$$

15. A 5.0-kg particle on the end of an ideal spring is pulled out a distance x_i from the equilibrium position and released from rest. The spring constant is 100 N/m and the speed of the particle as it passes the point where the spring force is zero is 5 m/s. If no friction acts on the system, what was the initial extended position, x_i?

3 **A.** 0.5 m

B. 1.1 m

3 **C.** 2.5 m

D. 1.3 m

E. 0.7 m

$$\Delta K + \Delta U = 0$$

$$K_f - \cancel{K_i} + \cancel{U_f} - U_i = 0$$

$$K_f = U_i$$

$$\cancel{\tfrac{1}{2}} m v_f^2 = \cancel{\tfrac{1}{2}} k x^2$$

$$x = \sqrt{\frac{m}{k}}\, v_f = \boxed{1.1\,m}$$

16. A 0.20-kg block is attached to an ideal spring which oscillates on a horizontal frictionless surface. The total mechanical energy, E, is 0.25 J. Find the velocity of the mass when the kinetic energy is one-third of the total energy, i.e. K=E/3. (*Hint: you don't need to know anything about the spring itself to do this, just understand energy for spring system!*)

3 ***A.*** 0.83 m/s
B. 0.75 m/s
C. 0.91 m/s
no um 3 ***D.*** 0.41 m/s
E. 0.25 m/s

$E = K + U$

$K \Rightarrow E/3 = \frac{1}{2} m v^2$

$v = \sqrt{\frac{\frac{2}{3}E}{m}} = \sqrt{\frac{2/3\,(0.25\,J)}{(0.2\,kg)}} = 0.913\ m/s$

17. A freight elevator with power 3000 Watts is used to move 12 refrigerators, 145 kg each, upwards 16 meters. The resulting time of the upward motion is:

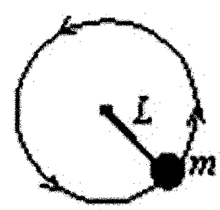
A. 0.63 s
(12) 3 ***B.*** 7.6 s
(g) 3 ***C.*** 9.3 s
D. 1.5 min
E. 1 hour

$P = \frac{mg \cdot d}{t} \Rightarrow t = \frac{mgd}{P}$

$t = \frac{(12)(145\,kg)(16\,m)(9.8\,m/s^2)}{3000\,W} = 90.944s$

$= 1.5\ min.$

18. A ball of mass *m*, at one end of a string of length *L*, rotates in a **vertical** circle just fast enough to prevent the string from going slack at the top of the circle. The speed of the ball at the bottom of the circle is:



(2) 4 ***A.*** $\sqrt{2gL}$
2 ***B.*** $\sqrt{3gL}$
C. $\sqrt{4gL}$
2 ***D.*** $\sqrt{5gL}$
2 ***E.*** $\sqrt{7gL}$

$\Delta K + \Delta U = 0$

$\cancel{K_f} - K_i + U_f - \cancel{U_i} = 0$

top bottom

$K_i = U_f$

$\frac{1}{2} m v_i^2 = 2mgL$

$v_i = \sqrt{4gL}$

19. A 1.0-kg block with an initial speed of 7 m/s slides a distance of 10 meters across a rough surface where it strikes a spring of spring constant 1200 N/m, compressing the spring a distance of 10 cm. Assuming constant friction for the entire distance, what is the coefficient of friction of the surface?

A. 1.0
(m) 4 ***B.*** 0.37
3 ***C.*** 0.25
D. 0.19
3 ***E.*** 0.06

$\Delta K + \Delta U = -f_k d$

$\cancel{K_f} - K_i + U_f - \cancel{U_i} = -f_k d = -\mu_k m g d$

then $\mu_k = \frac{\frac{1}{2} m v_i^2 - \frac{1}{2} k x^2}{mgd}$

$= \frac{\frac{1}{2}(1kg)(7\,m/s)^2 - \frac{1}{2}(1200\,N/m)(0.1\,m)^2}{(1kg)(9.8\,m/s^2)(10.1\,m)} = 0.186$

20. A 25 kg bear slides, from rest, 12 meters down a lodgepole pine tree, moving with a speed of 5.6 m/s just before hitting the ground. What is the average frictional force that acts on the sliding bear? *(Note: The initial height of the bear above the ground is also the distance the bear travels to reach the ground, d.)*

$\Delta K + \Delta U = -f_k d$

$K_f - \cancel{K_i} + \cancel{U_f} - U_i = -f_k d$

$f_k = \dfrac{\frac{1}{2}m v_f^2 - mgd}{(-d)} = \dfrac{-\frac{1}{2}(25kg)(5.6 m/s)^2 + (25kg)(9.8 m/s^2)(12 m)}{(12 m)}$

$= 212 N$

A. Zero

2 **B.** 33 N

C. 210 N

2 **D.** 245 N

4 **E.** 280 N

21. (2points extra credit) A person riding a Ferris Wheel at a carnival moves through positions at (1) the top, (2) the bottom and (3) mid-height. Rank the magnitude of the normal force on the person, greatest first.

A. I don't care to answer this question

B. 1, 2, 3

C. 2, 3, 1

D. 3, 2, 1

person feels like "floating" @ top

" squished in seat @ bottom

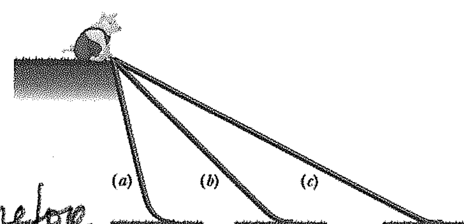
22. (2points extra credit) In the figure, a greased pig has a choice of 3 frictionless slides along which to slide to the ground. Rank the slides according to how much work the gravitational force does on the pig during the descent, greatest first.

A. I don't care to answer this question

B. All tie

C. c, b, a

D. a, b, c



each slide drops the same height therefore the same gravitational potential energy

23. (2points extra credit) A block is on a frictionless track that slides down through a height *h*. At the bottom of the track there is a horizontal plane with friction where the block stops in a distance *D*. If the height *h* is decreased, which of the following describes the distance for the block to come to a stop on the horizontal plane?

A. I don't care to answer this question

B. Greater than *D*

C. Equal to *D*

D. Less than *D*

as ΔU gets smaller, less Energy to travel along horizontal