Name: ____ Total Points: _______
(Last) (First)

Physics 201

Exam 2

Write also your name in the appropriate box of the scantron

Name: ____ Total Points: _______
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Multiple choice questions [60 points]

Answer all of the following questions. Read each question carefully. **Fill the correct bubble on your scantron sheet**. Each question has exactly one correct answer. All questions are worth the same amount of points.

1. A car travels east at constant velocity. The net force on the car is:

A. east
B. west
C. up
D. down
E. zero since the acceleration is 0 and $F_{net} = ma$.

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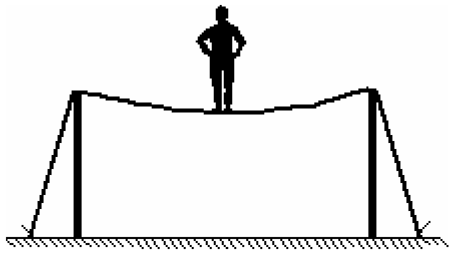
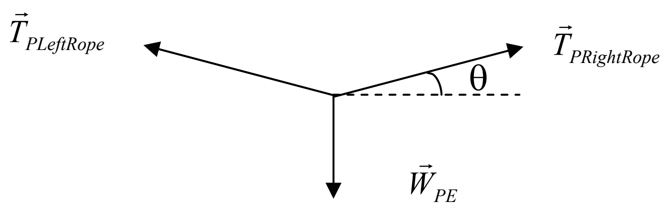
2. A circus performer of weight *W* is walking along a "high wire" as shown. The tension in the wire is:



Hint: Draw a free body diagram for the circus performer.

A. approximately *W*
B. approximately *W*/2
C. much less than *W*
D. much more than *W*
Draw a free body diagram for the performer



It follows (with T the magnitude of the tension in the rope)

$$-W_{PE} + 2T\sin\theta = 0 \Rightarrow T = \frac{W_{PE}}{2\sin\theta} \Rightarrow T >> W_{PE}$$ since θ is small.

E. depends on whether he stands on one or two feet

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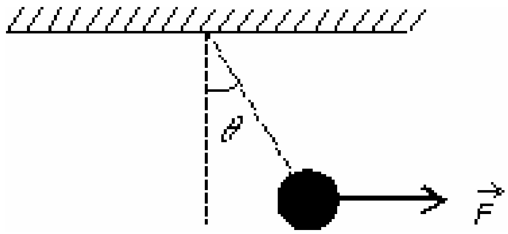
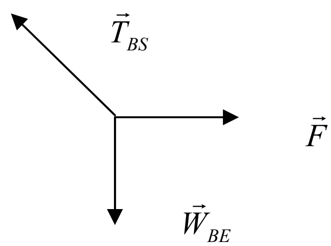
3. A 1-N pendulum bob is held at an angle θ from the vertical by a 2-N horizontal force F as shown. The tension in the string supporting the pendulum bob (in newtons) is:



A. $\cos\theta$
B. $2/\cos\theta$
C. $\sin\theta$
D. $\tan\theta$
E. $\sqrt{5}$

Draw a free body diagram for the bob



$$T_{BS} = \sqrt{W_{BE}^{\;2} + F^2} = \sqrt{5}\ N$$

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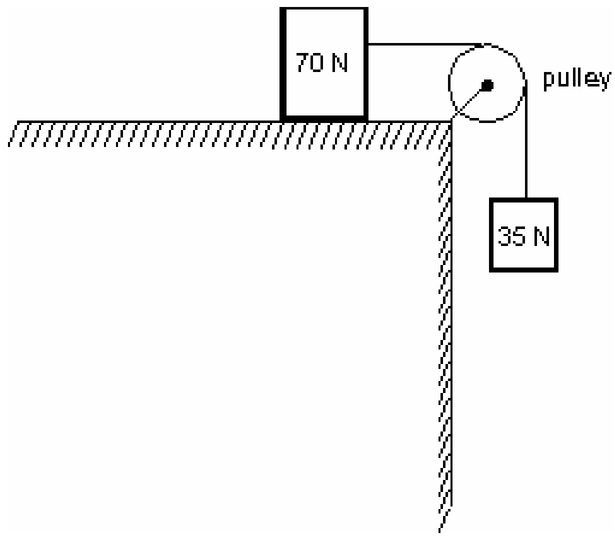
4. A 70 N block and an 35-N block are connected by a string as shown. If the pulley is massless and the surface is frictionless, the magnitude of the acceleration of the 70-N block is:



(Recall the similar computation done in lab)

A. **1.6 m/s^2**

B. **3.3 m/s^2**

for the 35 N block

$\vec{W}_{35E} + \vec{T}_{35S} = m_{35}\vec{a}_{35} \Rightarrow T_{35S} = W_{35E} - m_{35}a_{35} = 35 - m_{35}a_{35}$

And for the 70 N block

$\vec{T}_{70S} + \vec{W}_{70E} + \vec{N}_{70T} = m_{70}\vec{a}_{70} \Rightarrow T_{70S} = m_{70}a_{70}$

Use that

$T_{70S} = T_{35S}$ **and** $a_{70} = a_{35} = a$ **to get**

$$m_{70}a = 35 - m_{35}a \Rightarrow a = \frac{35}{(70+35)/9.8} = 3.3 m/s^2$$

C. **4.9 m/s^2**

D. **6.7 m/s^2**

E. **9.8 m/s^2**

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5. A horizontal shove of at least 200-N is required to start moving a 800-N crate initially at rest on a horizontal floor. The coefficient of static friction is:

A. 0.25
200N is the minimum force to accelerate the box. Thus it is equal to the maximum force of static friction:
$200 = \mu_s 800 \Rightarrow \mu_s = 0.25$

B. 0.125

C. 0.50

D. 0.75

E. 1.00

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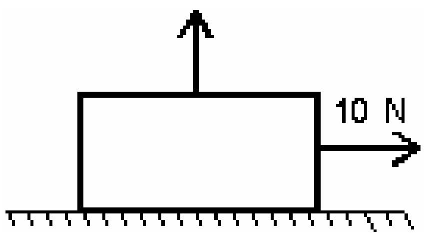
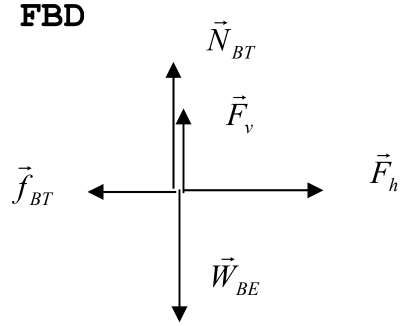
6. A box with a weight of 50 N rests on a horizontal surface. A person pulls horizontally on it with a force of 10 N and it does not move. To start it moving, a second person pulls vertically upward on the box. If the coefficient of static friction is 0.4, what is the smallest vertical force for which the box moves?



A. 4 N
B. 10 N
C. 14 N
25 N
Draw a FBD



D. the normal force acting on the box is

$N_{BT} = W_{BE} - F_v$

When the box starts moving, the friction force is equal to F_h

$f_{BT} = F_h$

$But \quad f_{BT} = \mu_S N_{BT} = \mu_S (W_{BE} - F_v)$

$$\Rightarrow F_v = W_{BE} - \frac{F_h}{\mu_S} = 50 - \frac{10}{0.4} = 25N$$

E. 35 N

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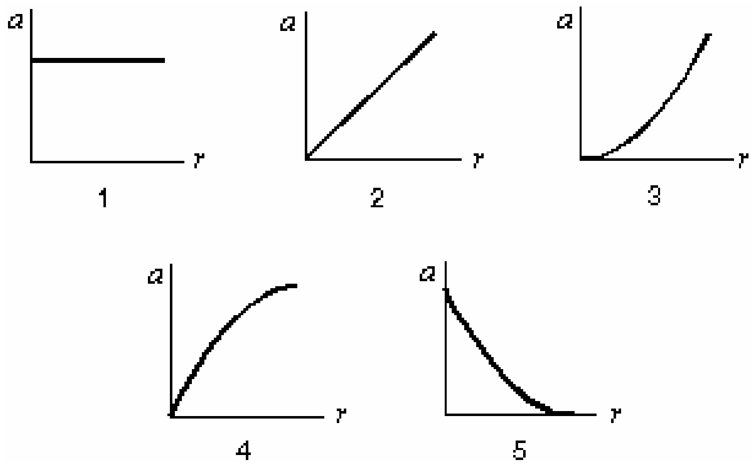
7. Which of the following five acceleration versus radius graphs is correct for a particle moving in a circle of radius *r* with acceleration *a* at a constant speed of 10 m/s?



A. 1
B. 2
C. 3
D. 4
E. 5 since $a = \frac{v^2}{r}$

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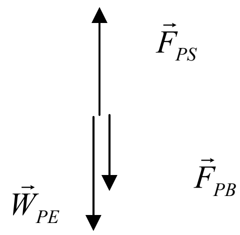
8. A person riding a Ferris wheel is strapped into her seat by a seat belt. The wheel is spun so that the centripetal acceleration is g. Select the correct combination of forces that act on her when she is at the top. In the table, W_{PE} = weight, down; F_{PB} = seat belt force, down; and F_{PS} = seat force, up.

A. $W_{PE} = 0,\ F_{PB} = mg,\ F_{PS} = 0$

$W_{PE} = mg,\ F_{PB} = 0,\ F_{PS} = 0$

Draw a FBD



B.

$$\vec{W}_{PE} + \vec{F}_{PS} + \vec{F}_{PB} = m\vec{a}$$

along the vertical (*positive is down*)

$$mg - F_{PS} + F_{PB} = mg \Rightarrow F_{PB} = F_{PS}$$

B is the only possible answer

C. $W_{PE} = 0,\ F_{PB} = 0,\ F_{PS} = mg$

D. $W_{PE} = mg,\ F_{PB} = mg,\ F_{PS} = 0$

E. $W_{PE} = mg,\ F_{PB} = 0,\ F_{PS} = mg$

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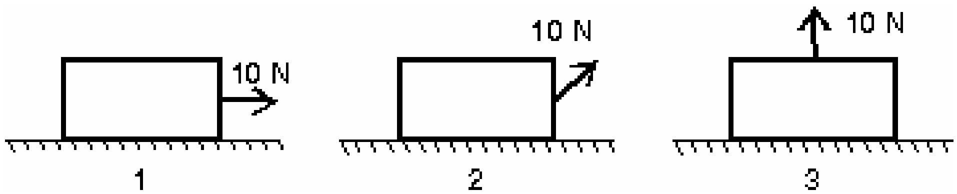
9. A crate moves to the right on a horizontal surface as a woman pulls on it with a 10-N force. Rank the situations shown below according to the work done by the 10-N force, least to greatest. The displacement is the same for all cases.



A. 3, 2, 1
Use $W = Fd\cos\theta$ $and \theta_1 = 0, \theta_2 \approx 45, \theta_3 = 90$

B. 2, 1, 3

C. 2, 3, 1

D. 1, 3, 2

E. 1, 2, 3

10. A man pulls a sled along a rough horizontal surface by applying a constant force $\vec{F}$ at an angle θ above the horizontal. In pulling the sled a horizontal distance *d*, the work done by the man is:

A. Fd

B. $Fd\cos\theta$

C. $Fd\sin\theta$

D. $Fd/\cos\theta$

E. Can't tell without knowing the coefficient of kinetic friction.

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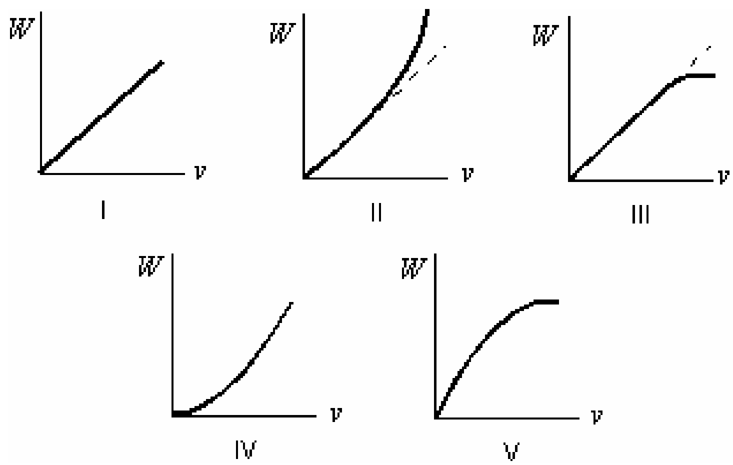
11. A particle is initially at rest on a horizontal frictionless table. It is acted upon by a constant horizontal force F. Which of the following five graphs is a correct plot of work W as a function of particle speed v?



Hint: use the work energy theorem

A. I

B. II

C. III

D. IV

$$\left.\begin{aligned} W &= K_f - K_i \\ K_f &= \frac{1}{2}mv^2 \\ K_i &= 0 \end{aligned}\right\} \Rightarrow W = \frac{1}{2}mv^2$$

E. V

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12. The velocity of a particle moving along the *x* axis changes from v_i to v_f. For which values of v_i and v_f is the total work done on the particle negative?

A. $v_i = 2\text{m/s}$, $v_f = 5\text{m/s}$
B. $v_i = -2\text{m/s}$, $v_f = 5\text{m/s}$
C. $v_i = -5\text{m/s}$, $v_f = 2\text{m/s}$
D. $v_i = 2\text{m/s}$, $v_f = -5\text{m/s}$
E. $v_i = -2\text{m/s}$, $v_f = -5\text{m/s}$

$$\left.\begin{aligned} W &= K_f - K_i \\ K_f &= \frac{1}{2}mv_f^2 \\ K_i &= \frac{1}{2}mv_i^2 \end{aligned}\right\} \Rightarrow W = \frac{1}{2}m(v_f^2 - v_i^2) \Rightarrow W < 0 \; if \; |v_f| < |v_i|$$

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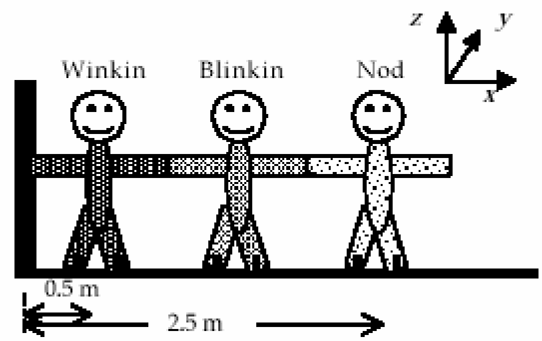
PROBLEM [40 points]



Winkin, Blinkin, and Nod are identical triplets, each having a mass m = 30.0 kg. They clasp arms in a line and go out on to an ice-covered pond.
Winkin grabs onto a post anchored in the ice with his free arm, and starts to go around the post. He soon reaches a constant speed, where he makes one complete revolution in a time T = 6.28 s.

The distance from the center of each boy to the end of his arm is 0.50 m, so that Nod's body is 2.5 m from the post and Blinkin's body is 1.5 m from the post. At the instant shown, the boys are lined up along the x-axis ($\hat{i}$), and skating at constant speed in the negative y direction ($-\hat{j}$, out of the page). The z-axis ($\hat{k}$) is vertical.

1). [10 pts] If the boys' arms stay rigid, what is Nod's velocity as he goes around the post? Measure his velocity at the center of his body which is 2.5 m from the post. Give the direction, units and magnitude. Explain.

Nod is moving on a circle at constant speed. Nod makes one revolution = 2πr in T.

$$v = \frac{2\pi r}{T} = 2.5 m/s$$

At the instant shown the direction of Nod's velocity is $-\hat{j}$ (as mentioned above)

2). [10 pts] What is Nod's acceleration vector at the instant shown (direction, units, and magnitude). Explain.

The acceleration is toward the center of the circle and has magnitude v^2/r (Nod is moving on a circle at constant speed).

$$\vec{a}_{Nod} = \frac{v^2}{r}(-\hat{i}) = -2.5\hat{i}\ m/s^2$$

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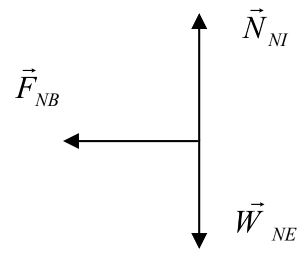
3). [15 pts]What is the force $\vec{F}_{BN}$ the force with which Nod pulls on Blinkin? Give the direction, units and magnitude. Explain.
According the Newton's 3rd law $\vec{F}_{BN} = -\vec{F}_{NB}$

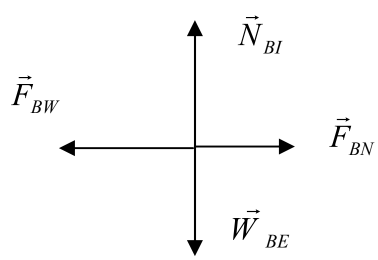
Draw a FBD for Nod



$\vec{F}_{NB} = m\vec{a}_N = -30 \times 2.5 \times \hat{i} = -75\hat{i}\ N$
Thus
$\vec{F}_{BN} = 75\hat{i}\ N$

4). [10 pts] What is the force $\vec{F}_{BW}$ the force with which Winkin pulls on Blinkin? Give the direction, units and magnitude. Explain.

Draw a FBD for Blinkin



The velocity of Blinkin is $\vec{v}_B = -1.5\hat{j}\ m/s$

The acceleration of Blinkin is $\vec{a}_B = -1.5\hat{i}\ m/s^2$

Thus $\vec{F}_{BW} + \vec{F}_{BN} = m\vec{a}_B \Rightarrow \vec{F}_{BW} = 30 \times (-1.5\hat{i}) - 75\hat{i} = -120\hat{i}\ N$