General Physics: Class Exam II

14 October 2019

Name: Solution **Total:** /70

Instructions

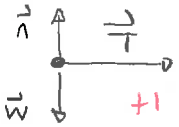
- There are 7 questions on 6 pages.
- Show your reasoning and calculations and always explain your answers.

Physical constants and useful formulae

$$g = 9.80\,\mathrm{m/s^2} \qquad G = 6.67 \times 10^{-11}\,\mathrm{Nm^2/kg^2}$$

Question 1

A 10 kg sled lies on a frictionless horizontal sheet of ice. A rope pulls the sled horizontally and, at one moment, it moves with velocity 10 m/s and has acceleration 3.0 m/s^2. Determine the tension in the rope.



$\Sigma F_x = ma_x$] +1

$T = ma_x$ +2

$T = 10\,\mathrm{kg} \times 3.0\,\mathrm{m/s^2} = 30\,\mathrm{N}$ +1 +1

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Question 2

A box moves with a constant speed to the right along a horizontal frictionless surface. *While this happens,* two ropes pull horizontally on the box from either side. Which of the following (choose one) is correct?

$\vec{a}=0 \Rightarrow \vec{F}_{net}=0$

$\Rightarrow T_{right} = T_{left}$

i) The tension in the right rope must equal that in the left.
ii) The tension in the right rope must be larger than in the left.
iii) The tension in the left rope must be larger than in the right.

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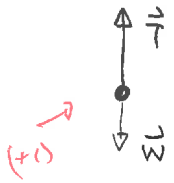
Question 3

A 8.0 kg fish hangs at rest from a rope. Starting at some initial moment a person pulls vertically upward on the rope with force 100 N. The person pulls for 1.5 s.

a) Determine the acceleration of the fish while the person pulls on the rope.



(+1) $\Sigma F_y = ma_y$

$W = mg = 8.0kg \times 9.8 m/s^2 = 78N$ (+1)

$T - W = ma_y$ (+2)

$100N - 78N = 8.0kg\, a_y \Rightarrow 21N = 8.0kg\, a_y$

$\Rightarrow a_y = \frac{21N}{8.0kg} = 2.6 m/s^2$ (+2)

b) Determine how far the fish moves vertically during the 1.5 s while the person is pulling upwards.

$y_f = y_i + v_{iy}\Delta t + \frac{1}{2} a_y \Delta t^2$ ← (+1)

@ $v_f = ?$, $y_f = 0$, $t = 1.5s$

$a = 2.6 m/s^2$

@ $v_i = 0$, $y_i = 0$

$y_f = \frac{1}{2} 2.6 m/s^2 (1.5s)^2 = 3.0m$ (+2)

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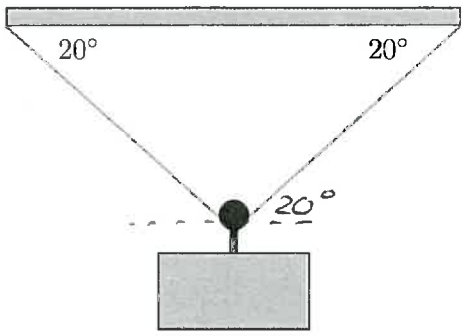
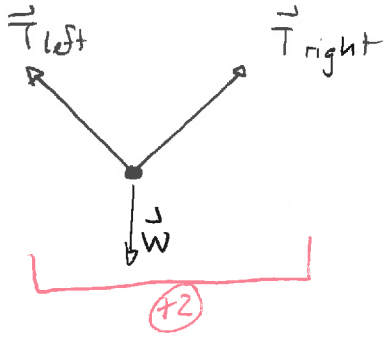
Question 4

A 50.0 kg block is supposed to be suspended at rest from a rigid support by a rope in the illustrated configuration. The rope runs through a massless pulley and thus the tension throughout it is the same. It is known that the rope will break once the tension in it exceeds 650 N. Determine the tension in the rope and describe whether it will break or not.





+2

$\Sigma F_x = ma_x = 0$

$\Sigma F_y = ma_y = 0$] +1

$W = Mg = 50.0\,kg \times 9.8\,m/s^2 = 490N$] +1

(+1)

$T_{right\,x} = T\cos 20°$ $\quad T_{right\,y} = T\sin 20°$

$T_{left\,x} = -T\cos 20°$ $\quad T_{left\,y} = T\sin 20°$] +4

	x	y
$\vec{W}$	0	$-490N$
T_{right}	$T\cos 20°$	$T\sin 20°$
T_{left}	$-T\cos 20°$	$T\sin 20°$

$\Sigma F_y = 0$

$\Rightarrow -490N + 2T\sin 20° = 0$] +4

$\Rightarrow -490N + 0.684T = 0 \Rightarrow T = \frac{490N}{0.684} = 720N$] +2

Does not break

+1

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Question 5

A 4.0 kg red ball collides with a 1.0 kg blue ball and they bounce off each other. Let $F_{\text{red on blue}}$ represent the force exerted by the red ball on the blue and $F_{\text{blue on red}}$ represent the force exerted by the blue ball on the red. Which of the following (choose one) is true while the balls collide?

i) $F_{\text{red on blue}}$ is the same as $F_{\text{blue on red}}$. Newton's Third Law

ii) $F_{\text{red on blue}}$ is two times $F_{\text{blue on red}}$.

iii) $F_{\text{red on blue}}$ is four times $F_{\text{blue on red}}$.

iv) $F_{\text{red on blue}}$ is one quarter of $F_{\text{blue on red}}$.

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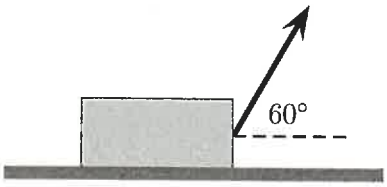
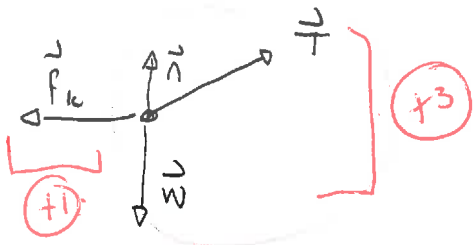
Question 6

A 9.0 kg block is pulled by a string on which the tension is 80 N. The angle between the string and the horizontal is 60° as illustrated. The block moves to the right along the horizontal surface. The coefficient of kinetic friction between the block and the surface is 0.60.



a) Draw a free body diagram for the block.



b) Determine the normal force exerted by the surface on the block.

$\Sigma F_x = ma_x$

$\Sigma F_y = ma_y = 0$] +1

$w = mg = 9.0\text{kg} \times 9.8\text{m/s}^2 = 88.2\text{N}$] +1

Question 6 continued ...

$T_x = T\cos 60°$

$= 80N\cos 60°$

$= 40N$

$T_y = T\sin 60°$

$= 69N$

	x	y
n	0	n
w	0	-88.2N
T	40N	69 N
f_k	$-f_k$	0

$\Sigma F_y = 0 \Rightarrow n - 88.2N + 69N = 0$

$\Rightarrow n = 19N$

c) Determine the kinetic friction force exerted by the surface on the block.

$f_k = \mu_k n$

$= 0.60 \times 19N = 11\ N$

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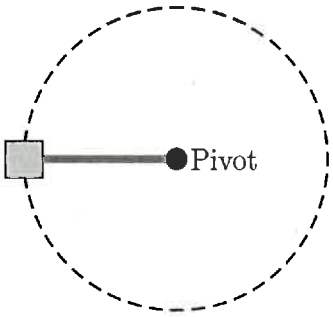
Question 7

A 2.00 kg block is attached to a string that is fixed to a pivot point. The block swings in a horizontal circle with radius 0.500 m. The block is supported by a frictionless table while this occurs. The diagram shows this as viewed from above. The block completes one circle in 0.250 s.

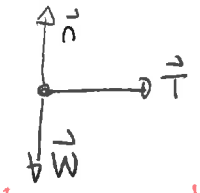


a) Determine the speed of the block.

$$v = \frac{2\pi r}{T} = \frac{2\pi \times 0.500\,m}{0.250\,s} = 12.6\,m/s$$

(+1) (+2)

b) Determine the tension in the string.



(+1)

$\Sigma F_x = ma_x$ (+1)

$T = ma = \frac{mv^2}{r}$ (+1)

(+2)

$= 2.00\,kg \times \frac{(12.6\,m/s)^2}{0.500\,m}$

$= 632\,N$

(+3)

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