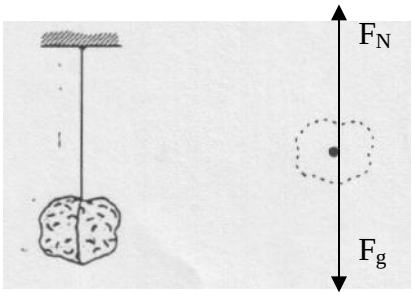
Physics 20 - Lesson 17
Vertical Forces and Inclines – Answer Key

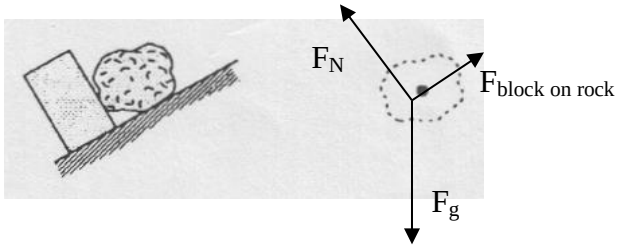
Possible 81 / 71

1) 2 marks each for a total of 14 marks

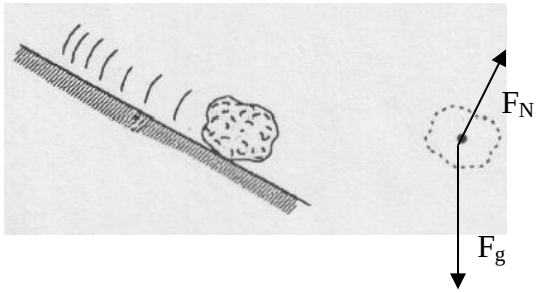
A. Static



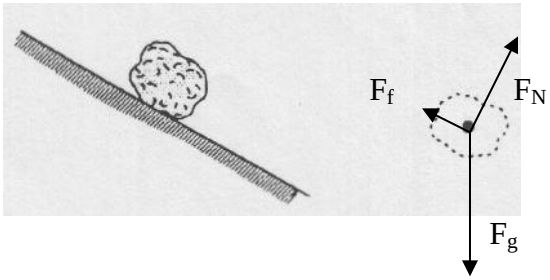
B. Static



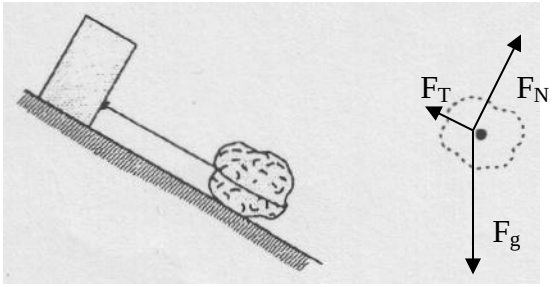
C. Sliding without friction.



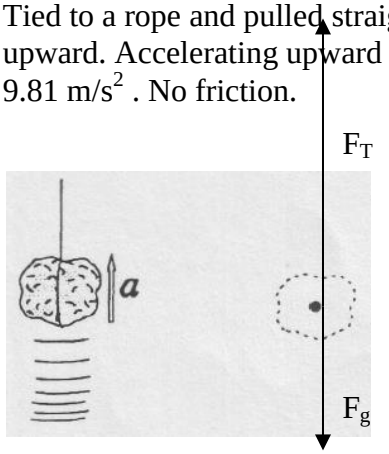
D. Static friction prevents sliding.



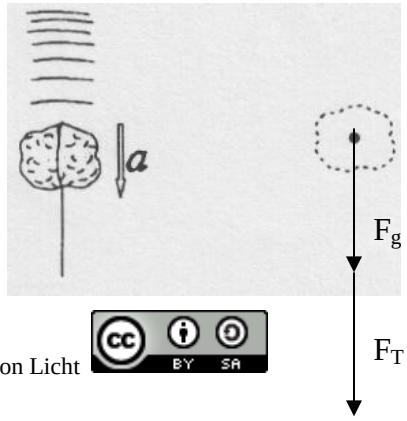
E. Static



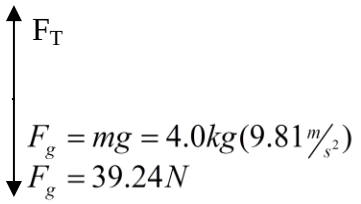
F. Tied to a rope and pulled straight upward. Accelerating upward at 9.81 m/s^2 . No friction.



G. Tied to a rope and pulled straight downward. Accelerating downward at 19.62 m/s^2. No friction.



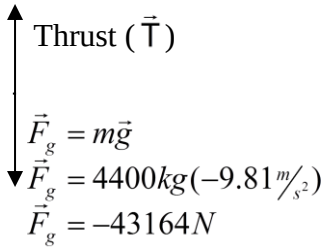
2) /5



Constant velocity $\rightarrow a = 0$

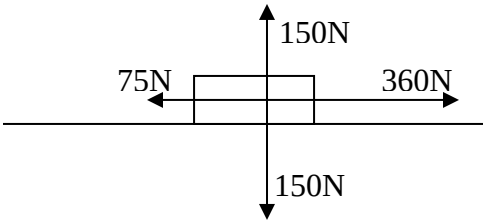
$\vec{F}_{net} = m\vec{a}$
$\vec{F}_T + \vec{F}_g = m\vec{a}$
$\vec{F}_T - 39.24N = 4.0kg(0)$
$\boxed{\vec{F}_T = 39.24N}$

3) /6



$\vec{F}_{net} = m\vec{a}$
$\vec{T} + \vec{F}_g = m\vec{a}$
$\vec{T} = m\vec{a} - \vec{F}_g$
$\vec{T} = (4400kg)(+8.5\,m/s^2) - (-43164N)$
$\boxed{\vec{T} = +80564N}$

4) /6

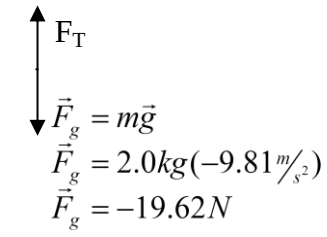


$\vec{F}_{net} = 360N - 75N$
$\vec{F}_{net} = 285N$

$m = \dfrac{F_g}{g} = \dfrac{150N}{9.81m/s^2}$
$m = 15.29kg$

$\vec{F}_{net} = m\vec{a}$
$285N = (15.29kg)\vec{a}$
$\boxed{\vec{a} = 18.6m/s^2}$

5) /11



a) $\vec{F}_{net} = m\vec{a}$
$\vec{F}_T + \vec{F}_g = m\vec{a}$
$\vec{F}_T + (-19.62N) = 0$
$\boxed{\vec{F}_T = +19.62N}$

Since constant velocity is dynamically the same as zero velocity, (b) and (c) are the same as (a).

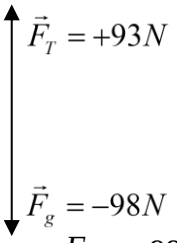
b) $\boxed{\vec{F}_T = 19.62N}$

c) $\boxed{\vec{F}_T = 19.62N}$

d) $\vec{F}_{net} = m\vec{a}$
$\vec{F}_T + \vec{F}_g = m\vec{a}$
$\vec{F}_T + (-19.62N) = 2.0kg(-2.0\,m/s^2)$
$\vec{F}_T = 2.0kg(-2.0\,m/s^2) + 19.62N$
$\boxed{\vec{F}_T = +15.62N}$

e) $\vec{F}_{net} = m\vec{a}$
$\vec{F}_T + \vec{F}_g = m\vec{a}$
$\vec{F}_T + (-19.62N) = 2.0kg(+2.0\,m/s^2)$
$\vec{F}_T = 2.0kg(+2.0\,m/s^2) + 19.62N$
$\boxed{\vec{F}_T = +23.62N}$

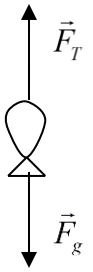
6) /4



$$m = \frac{F_g}{g} = \frac{98N}{9.81\,{}^{m}/_{s^2}} = 10kg$$

$$\vec{F}_{net} = m\vec{a}$$
$$\vec{F}_T + \vec{F}_g = m\vec{a}$$
$$+93N + (-98N) = 10kg\ \vec{a}$$
$$\boxed{\vec{a} = -0.50\,{}^{m}/_{s^2}}$$
$$\boxed{\vec{a} = 0.50\,{}^{m}/_{s^2}\ \text{(down)}}$$

7) Bonus /10



a)

$$\vec{F}_{net} = m\vec{a}$$
$$\vec{F}_T + \vec{F}_g = m\vec{a}$$
$$\vec{F}_T + m\vec{g} = m\vec{a}$$
$$200 + (-9.81m) = 1.2m$$
$$200 = 11.01m$$
$$m = \frac{200}{11.01}$$
$$m = 18.17kg$$

$$F_g = mg = 18.17kg(9.81\,{}^{m}/_{s^2})$$
$$\boxed{F_g = 178N}$$

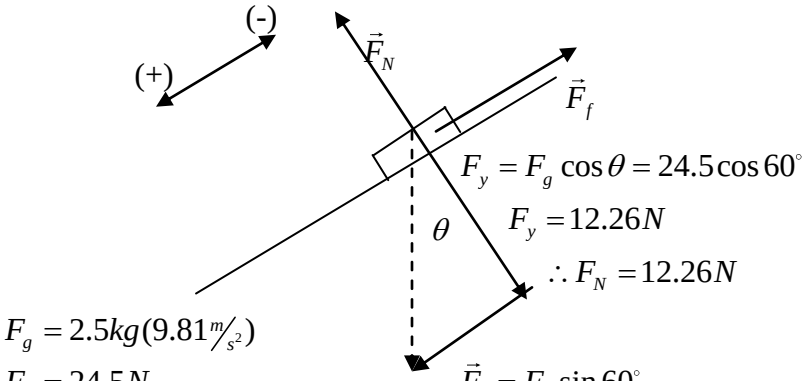
b)

$$\vec{F}_T + \vec{F}_g = m\vec{a}$$
$$+150N + (-178N) = 18.17kg\ \vec{a}$$
$$-28 = 18.17\vec{a}$$
$$\vec{a} = 11.01m$$
$$m = \frac{200}{11.01}$$
$$\boxed{\vec{a} = -1.55\,{}^{m}/_{s^2}}$$

c) If the cable snaps $\vec{F}_{net} = \vec{F}_g$

$$\vec{F}_T + \vec{F}_g = \vec{F}_{net}$$
$$\vec{F}_T + \vec{F}_g = \vec{F}_g$$
$$\boxed{\vec{F}_T = 0}$$

8) /8



$$F_g = 2.5kg(9.81\,{}^{m}/_{s^2})$$
$$F_g = 24.5N$$

$$F_y = F_g \cos\theta = 24.5\cos 60^\circ$$
$$F_y = 12.26N$$
$$\therefore F_N = 12.26N$$

$$\vec{F}_x = F_g \sin 60^\circ$$
$$\vec{F}_x = +21.24N$$

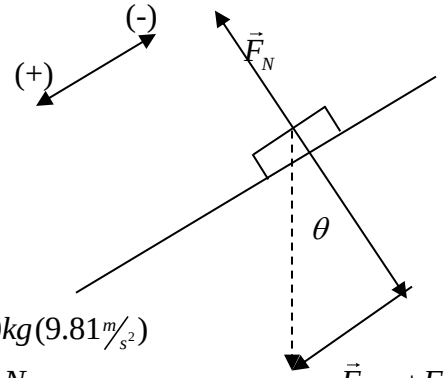
Friction Force

$$F_f = \mu F_n$$
$$F_f = 0.12(12.2N)$$
$$F_f = 1.47N$$

Acceleraton

$$\vec{F}_{net} = m\vec{a}$$
$$+21.24N + (-1.47N) = 2.5\vec{a}$$
$$\boxed{\vec{a} = +7.91\,{}^{m}/_{s^2}}$$

9) /8



$F_g = 10.0kg(9.81\,^{m}/_{s^2})$

$F_g = 98.1N$

$\vec{F}_x = +F_g \sin 45^\circ$

$\vec{F}_x = +98.1N \sin 45^\circ$

$\vec{F}_x = +69.37N$

$\vec{a} = \dfrac{\vec{F}_{net}}{m}$

$\vec{a} = \dfrac{69.37N}{10.0kg}$

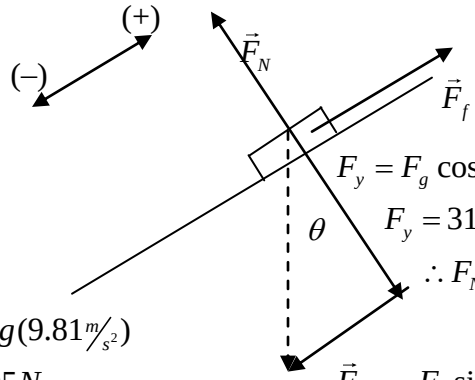
$\boxed{\vec{a} = 6.94\,^{m}/_{s^2}}$

$\vec{v}_2^{\,2} = \vec{v}_1^{\,2} + 2\vec{a}\Delta\vec{d}$

$\vec{v}_2 = \sqrt{2(6.937\,^{m}/_{s^2})(20m)}$

$\boxed{v_2 = 16.7m/s}$

10a) /6



$F_g = 5.0kg(9.81\,^{m}/_{s^2})$

$F_g = 49.05N$

$F_y = F_g \cos\theta = 49.05\cos 50^\circ$

$F_y = 31.53N$

$\therefore F_N = 31.53N$

$\vec{F}_x = -F_g \sin 60^\circ = -49.05N \sin 60^\circ$

$\vec{F}_x = -37.57N$

Friction Force

$F_f = \mu F_n$

$F_f = 0.10(31.53N)$

$F_f = 3.15N$

Acceleraton

$\vec{F}_{net} = m\vec{a}$

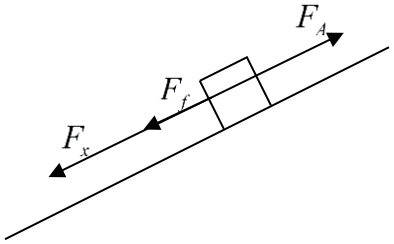
$-37.57N + (+3.15N) = 5.0\vec{a}$

$\boxed{\vec{a} = -6.88\,^{m}/_{s^2}}$

10b) Refer to #10a

The frictional force acts in the opposite direction

/3



$\vec{F}_{net} = m\vec{a}$

$\vec{F}_A + \vec{F}_x + \vec{F}_f = 5.0(2.0\,^{m}/_{s^2})$

$\vec{F}_A + (-37.57N) + (-3.15N) = +10N$

$\boxed{\vec{F}_A = +50.65N}$