Correct answers are circled. The first 30 problems are 10 exam problems each of which have 3 versions. Make sure you compare with the numbers that you had in the exam. Complete solutions are at the end of the document.

Instructor: *Ihas/Biswas*

PHYSICS DEPARTMENT

PHY 2053 Exam 1, 120 minutes October 8, 2008

Name (print, last first): ____________________________ Signature: ____________________________

On my honor, I have neither given nor received unauthorized aid on this examination.

DIRECTIONS

(1) **Code your test number (THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE) on your answer sheet using lines 76–80. Write your test number down and take it with you.** Code your name on your answer sheet. Code your UFID number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) You may do scratch work anywhere on this exam. **Circle your answers on the test form.** At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout.
(4) **Fill in the circles of your intended answers completely on the answer sheet, using a #2 pencil or blue or black ink.** Do not make any stray marks or some answers may be counted as incorrect.
(5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing.
(6) **Hand in the answer sheet separately, showing your UFID.**

Useful information: $g = 9.80$ m/s^2 Neglect air resistance. All ropes, strings, and pulleys are massless.

1. A daredevil decides to jump a canyon. The walls of the canyon are equally high and 10.0 m apart. He takes off by driving a motorcycle up a short ramp sloped at an angle of 22°. What minimum speed (in m/s) must he have in order to clear the canyon?

[✓ (1) 11.9] (2) 17.1 (3) 15.5 (4) 9.80 (5) 22.0

2. A daredevil decides to jump a canyon. The walls of the canyon are equally high and 15.0 m apart. He takes off by driving a motorcycle up a short ramp sloped at an angle of 15°. What minimum speed (in m/s) must he have in order to clear the canyon?

(1) 11.9 [✓ (2) 17.1] (3) 15.5 (4) 9.80 (5) 22.0

3. A daredevil decides to jump a canyon. The walls of the canyon are equally high and 10.0 m apart. He takes off by driving a motorcycle up a short ramp sloped at an angle of 12°. What minimum speed (in m/s) must he have in order to clear the canyon?

(1) 11.9 (2) 17.1 [✓ (3) 15.5] (4) 9.80 (5) 22.0

4. Runner A is initially 7.00 mi west of a flagpole and is running with a constant velocity of 7.00 mi/h due east. Runner B is initially 7.00 mi east of the flagpole and is running with a constant velocity of 4.00 mi/h due west. How far (in miles) are the runners from the flagpole when they meet?

[✓ (1) 1.91] (2) 0.545 (3) 5.00 (4) 7.00 (5) 9.51

5. Runner A is initially 5.00 mi west of a flagpole and is running with a constant velocity of 7.00 mi/h due east. Runner B is initially 2.00 mi east of the flagpole and is running with a constant velocity of 4.00 mi/h due west. How far (in miles) are the runners from the flagpole when they meet?

(1) 1.91 [✓ (2) 0.545] (3) 5.00 (4) 7.00 (5) 9.51

6. Runner A is initially 9.00 mi west of a flagpole and is running with a constant velocity of 2.00 mi/h due east. Runner B is initially 1.00 mi east of the flagpole and is running with a constant velocity of 3.00 mi/h due west. How far (in miles) are the runners from the flagpole when they meet?

(1) 1.91 (2) 0.545 [✓ (3) 5.00] (4) 7.00 (5) 9.51

7. A parachutist with a camera descends in free fall at a speed of 12.0 m/s. The parachutist releases the camera at an altitude of 100 m. How long does it take the camera to reach the ground?

[✓ (1) 3.46 s] (2) 1.85 s (3) 2.42 s (4) 1.00 s (5) 9.80 s

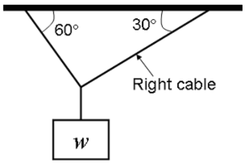
8. A parachutist with a camera descends in free fall at a speed of 18.0 m/s. The parachutist releases the camera at an altitude of 50.0 m. How long does it take the camera to reach the ground?

(1) 3.46 s [✓ (2) 1.85 s] (3) 2.42 s (4) 1.00 s (5) 9.80 s

9. A parachutist with a camera descends in free fall at a speed of 17.0 m/s. The parachutist releases the camera at an altitude of 70.0 m. How long does it take the camera to reach the ground?

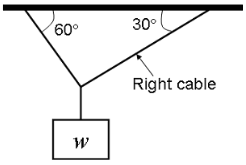
(1) 3.46 s (2) 1.85 s [✓ (3) 2.42 s] (4) 1.00 s (5) 9.80 s

10. A 170 N weight w is supported by three cables as shown in the figure. Find the tension in the right cable.



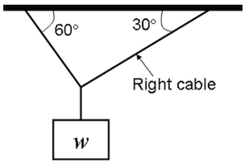
[✓ (1) 85.0 N] (2) 57.0 N (3) 65.0 N (4) 170 N (5) 114 N

11. A 114 N weight w is supported by three cables as shown in the figure. Find the tension in the right cable.



(1) 85.0 N [✓ (2) 57.0 N] (3) 65.0 N (4) 170 N (5) 114 N

12. A 130 N weight w is supported by three cables as shown in the figure. Find the tension in the right cable.



(1) 85.0 N (2) 57.0 N [✓ (3) 65.0 N] (4) 170 N (5) 114 N

13. A block of mass 2.50 kg is pushed 3.00 m along a frictionless horizontal table by a constant 12.0 N force directed 25.0° below the horizontal. Determine the work done by the applied force.

[✓ (1) 32.6 J] (2) 43.5 J (3) 25.4 J (4) 28.0 J (5) 36.0 J

14. A block of mass 2.50 kg is pushed 2.40 m along a frictionless horizontal table by a constant 20.0 N force directed 25.0° below the horizontal. Determine the work done by the applied force.

(1) 32.6 J [✓ (2) 43.5 J] (3) 25.4 J (4) 28.0 J (5) 36.0 J

15. A block of mass 2.50 kg is pushed 2.00 m along a frictionless horizontal table by a constant 14.0 N force directed 25.0° below the horizontal. Determine the work done by the applied force.

(1) 32.6 J (2) 43.5 J [✓ (3) 25.4 J] (4) 28.0 J (5) 36.0 J

16. An outfielder throws a 0.150 kg baseball at a speed of 56.0 m/s and an initial angle of 30.0°. What is the kinetic energy of the ball at the highest point of its motion?

[✓ (1) 176 J] (2) 38.0 J (3) 50.6 J (4) 0.00 J (5) 100 J

17. An outfielder throws a 0.150 kg baseball at a speed of 26.0 m/s and an initial angle of 30.0°. What is the kinetic energy of the ball at the highest point of its motion?

(1) 176 J [✓ (2) 38.0 J] (3) 50.6 J (4) 0.00 J (5) 100 J

18. An outfielder throws a 0.150 kg baseball at a speed of 30.0 m/s and an initial angle of 30.0°. What is the kinetic energy of the ball at the highest point of its motion?

(1) 176 J (2) 38.0 J [✓ (3) 50.6 J] (4) 0.00 J (5) 100 J

19. A skier (m=70.0 kg), starting from rest, slides down a 20° slope to a flat area 20.0 m vertically below her. At what speed does she reach the flat part if the coefficient of friction between her skis and the snow is 0.1?

[✓ (1) 16.8 m/s] (2) 11.9 m/s (3) 20.6 m/s (4) 70.0 m/s (5) 9.81 m/s

20. A skier (m=70.0 kg), starting from rest, slides down a 20° slope to a flat area 10.0 m vertically below her. At what speed does she reach the flat part if the coefficient of friction between her skis and the snow is 0.1?

(1) 16.8 m/s [✓ (2) 11.9 m/s] (3) 20.6 m/s (4) 70.0 m/s (5) 9.81 m/s

21. A skier (m=70.0 kg), starting from rest, slides down a 20° slope to a flat area 30.0 m vertically below her. At what speed does she reach the flat part if the coefficient of friction between her skis and the snow is 0.1?

(1) 16.8 m/s (2) 11.9 m/s [✓ (3) 20.6 m/s] (4) 70.0 m/s (5) 9.81 m/s

22. A diver drops (does not jump) from a platform 10.0 m above the water. If he weighs 700 N, what is his speed just as he hits the water?

[✓ (1) 14.0 m/s] (2) 19.8 m/s (3) 24.3 m/s (4) 10.0 m/s (5) 70.0 m/s

23. A diver drops (does not jump) from a platform 20.0 m above the water. If he weighs 700 N, what is his speed just as he hits the water?

(1) 14.0 m/s [✓ (2) 19.8 m/s] (3) 24.3 m/s (4) 10.0 m/s (5) 70.0 m/s

24. A diver drops (does not jump) from a platform 30.0 m above the water. If he weighs 700 N, what is his speed just as he hits the water?

(1) 14.0 m/s (2) 19.8 m/s [✓ (3) 24.3 m/s] (4) 10.0 m/s (5) 70.0 m/s

25. For Atwood's Machine what is the acceleration (in m/s^2) of each mass if $m_1 = 3.0$ kg and $m_2 = 5.0$ kg?

[✓ (1) 2.5] (2) 5.3 (3) 7.2 (4) 4.9 (5) 9.8

26. For Atwood's Machine what is the acceleration (in m/s^2) of each mass if $m_1 = 3.0$ kg and $m_2 = 10$ kg?

(1) 2.5 [✓ (2) 5.3] (3) 7.2 (4) 4.9 (5) 9.8

27. For Atwood's Machine what is the acceleration (in m/s^2) of each mass if $m_1 = 3.0$ kg and $m_2 = 20$ kg?

(1) 2.5 (2) 5.3 [✓ (3) 7.2] (4) 4.9 (5) 9.8

28. A ball is rolled horizontally off a table with an initial speed of 0.240 m/s. A stop watch measures the ball's trajectory time from table to the floor to be 0.300 s. How far away from the table does the ball land?

[✓ (1) 0.072 m] (2) 0.144 m (3) 0.288 m (4) 0.512 m (5) 0.981 m

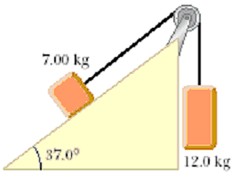
29. A ball is rolled horizontally off a table with an initial speed of 0.240 m/s. A stop watch measures the ball's trajectory time from table to the floor to be 0.600 s. How far away from the table does the ball land?

(1) 0.072 m [✓ (2) 0.144 m] (3) 0.288 m (4) 0.512 m (5) 0.981 m

30. A ball is rolled horizontally off a table with an initial speed of 0.240 m/s. A stop watch measures the balls trajectory time from table to the floor to be 1.20 s. How far away from the table does the ball land?

(1) 0.072 m (2) 0.144 m [✓ (3) 0.288 m] (4) 0.512 m (5) 0.981 m

31. Find the acceleration (in m/s^2) reached by each of the two objects shown in the figure if the coefficient of kinetic friction between the 7.00 kg object and the plane is 0.290.



[✓ (1) 3.18] (2) 9.80 (3) 0.290 (4) 12.0 (5) 7.00

32. A block of mass 10 kg slides 5.0 m down a rough inclined plane which makes an angle of 30° above the horizontal. The coefficient of kinetic friction between the block and the inclined plane is 0.2. What is the work (in J) done by normal reaction force on the block?

[✓ (1) 0.00] (2) 50.0 (3) 10.0 (4) 245 (5) 85.0

33. A plane is moving due north, directly towards its destination. Its airspeed (speed relative to air) is 200 mph. A constant breeze is blowing from west to east at 40 mph. How long will it take for the plane to travel 200 miles north?

[✓ (1) more than one hour]
(2) one hour
(3) less than one hour
(4) more information is needed
(5) The plane will not be able to fly

34. The acceleration due to gravity on the Moon's surface is one- sixth that on Earth. What net force would be required to accelerate a 20.0 -kg object at 6.00 m/s^2 on the moon?

[✓ (1) 120 N] (2) 20.0 N (3) 33.0 N (4) 1.30 N (5) 1.63 N

35. A 50-N crate is pulled up a 5.0-m inclined plane by a worker at constant velocity. If the plane is inclined at an angle of 37° to the horizontal and there exists a constant frictional force of 10 N between the crate and the surface, what is the force applied by the worker?

[✓ (1) 40 N] (2) 20 N (3) 30 N (4) 0.0 N (5) 10 N

36. Three identical 6.0-kg cubes are placed on a horizontal frictionless surface in contact with one another. The cubes are lined up from left to right and a force is applied to the left side of the left cube causing all three cubes to accelerate to the right at 2.0 m/s^2. What is the magnitude of the force exerted on the right cube by the middle cube in this case?

[✓ (1) 12 N] (2) 24 N (3) 36 N (4) none of the other answers is correct (5) 48 N

37. What are the dimensions of work?

[✓ (1) ML^2T^{-2}] (2) ML^2T^{-1} (3) MLT^{-2} (4) $M^2L^2T^{-2}$ (5) MT^{-2}

38. A 10.0-kg mass is placed on a 25.0° incline and friction keeps it from sliding. The coefficient of static friction in this case is 0.580 and the coefficient of sliding (kinetic) friction is 0.520. The mass is given a shove causing it to slide down the incline. Taking down the incline as positive, what is the acceleration of the mass while it is sliding?

[✓ (1) -0.477 m/s^2] (2) 0.477 m/s^2 (3) 1.99 m/s^2 (4) -1.99 m/s^2 (5) 0.00 m/s^2

39. An airplane of mass 1.2×10^4 kg tows a glider of mass 0.6×10^4 kg. The airplane propellers provide a net forward thrust of 3.6×10^4 N. What is the glider's acceleration?

[✓ (1) 2.0 m/s^2] (2) 3.0 m/s^2 (3) 6.0 m/s^2 (4) 9.8 m/s^2 (5) 1.0 m/s^2

40. Have you entered your identifying information correctly on the answer form (bubble sheet)? The information, your name, UFID (8 digits, no space or hyphen), and exam code (5 digits), must be bubbled in the appropriate rows.

[✓ (1) yes] (2) no (3) no (4) no (5) no

FOLLOWING GROUPS OF QUESTIONS WILL BE SELECTED AS ONE GROUP FROM EACH TYPE
TYPE 1
Q# S 1
Q# S 2
Q# S 3
TYPE 2
Q# S 4
Q# S 5
Q# S 6
TYPE 3
Q# S 7
Q# S 8
Q# S 9
TYPE 4
Q# S 10
Q# S 11
Q# S 12
TYPE 5
Q# S 13

Q# S 14
Q# S 15
TYPE 6
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Q# S 18
TYPE 7
Q# S 19
Q# S 20
Q# S 21
TYPE 8
Q# S 22
Q# S 23
Q# S 24
TYPE 9
Q# S 25
Q# S 26
Q# S 27
TYPE 10
Q# S 28
Q# S 29
Q# S 30

①

$$v_{oy} = v_o \sin\theta$$

$$\Delta y = 0$$

$$\Delta y = v_{oy}t + \frac{1}{2}at^2$$

$$\Rightarrow 0 = v_{oy}t - \frac{gt^2}{2}$$

$$\Rightarrow t = \frac{2v_{oy}}{g}$$

$$v_{ox} = v_o \cos\theta$$

$$R = v_{ox}t = \frac{2v_{oy}v_{ox}}{g} = \frac{2v_o \sin\theta \, v_o \cos\theta}{g}$$

$$= \frac{v_o^2 \sin 2\theta}{g}$$

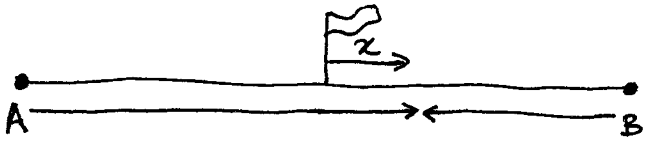
$$\Rightarrow v_o = \sqrt{\frac{Rg}{\sin 2\theta}}$$

for $\left.\begin{matrix} R = 10\,\text{m} \\ \theta = 22^\circ \end{matrix}\right\}$ $v_o = 11.9$ m/s

$\left.\begin{matrix} R = 15\,\text{m} \\ \theta = 15^\circ \end{matrix}\right\}$ $v_o = 17.1$ m/s

$\left.\begin{matrix} R = 10\,\text{m} \\ \theta = 12^\circ \end{matrix}\right\}$ $v_o = 15.5$ m/s

②



$$t_A = \frac{x + x_A}{v_A}$$

$$t_B = \frac{x - x_B}{-v_B}$$

$$t_A = t_B \Rightarrow \frac{x + x_A}{v_A} = \frac{x_B - x}{v_B}$$

$$\Rightarrow v_B x + x_A v_B = x_B v_A - x v_A$$

$$\Rightarrow x(v_A + v_B) = x_B v_A - x_A v_B$$

$$\Rightarrow x = \frac{x_B v_A - x_A v_B}{v_A + v_B}$$

for $x_A = 7$ mi, $x_B = 7$ mi, $v_A = 7$ mi/h, $v_B = 4$ mi/h

$$x = \frac{7 \times 7 - 7 \times 4}{7 + 4} = 1.91 \text{ mi}$$

for $x_A = 5$ mi, $x_B = 2$ mi, $v_A = 7$ mi/h, $v_B = 4$ mi/h

$$x = \frac{2 \times 7 - 5 \times 4}{7 + 4} = -0.545 \text{ mi} \Rightarrow |x| = 0.545 \text{ miles}$$

for $x_A = 9$ mi, $x_B = 1$ mi, $v_A = 2$ mi/h, $v_B = 3$ mi/h

$$x = \frac{1 \times 2 - 9 \times 3}{2 + 3} = -5.00 \text{ mi} \Rightarrow |x| = 5.00 \text{ miles}$$

③ $\Delta y = v_{oy} t + \frac{1}{2} a t^2 = v_{oy} t - 4.9 t^2$

$$\Rightarrow 4.9 t^2 - v_{oy} t + \Delta y = 0$$

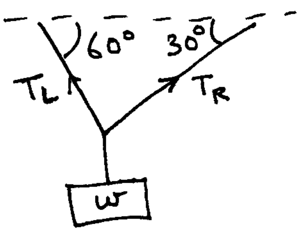
$$\Rightarrow t = \frac{v_{oy} \pm \sqrt{v_{oy}^2 - 19.6 \Delta y}}{9.8}$$

for $v_{oy} = -12$ m/s, $\Delta y = -100$ m, $t = 3.46$ s

$v_{oy} = -18$ m/s, $\Delta y = -50$ m, $t = 1.85$ s

$v_{oy} = -17$ m/s, $\Delta y = -70$ m, $t = 2.42$ s

④



$(T_R \cos 30° - T_L \cos 60° = 0) \times \sin 60° \rightarrow ①$

$(T_R \sin 30° + T_L \sin 60° = w) \times \cos 60° \rightarrow ②$

from ① & ②

$$T_R \underbrace{(\cos 30° \sin 60° + \sin 30° \cos 60°)}_{=1} = \omega \cos 60°$$

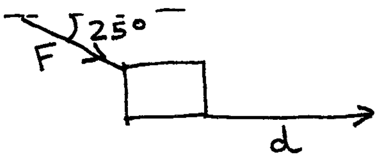
$$\Rightarrow T_R = \omega \cos 60°$$

if $\omega = 170$ N, $T_R = 85$ N

$\omega = 114$ N, $T_R = 57$ N

$\omega = 130$ N, $T_R = 65$ N

⑤



$W = Fd\cos\theta = Fd \cos 25°$

For $F = 12$ N, $d = 3$ m, $W = 32.6$ J

$F = 20$ N, $d = 2.4$ m, $W = 43.5$ J

$F = 14$ N, $d = 2$ m, $W = 25.4$ J

⑥ at the highest point $v_y = 0$ and $v_x = v_{0x}$

$v_{0x} = v_0 \cos 30°$

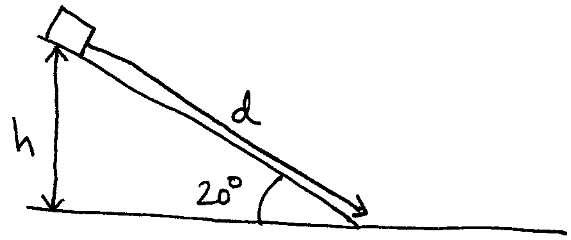
$KE = \frac{1}{2} m v_0^2 \cos^2 30° = 0.056\, v_0^2$

for $v_0 = 56$ m/s, $KE = 176$ J

$v_0 = 26$ m/s, $KE = 38$ J

$v_0 = 30$ m/s, $KE = 50.6$ J

⑦



$$W_{nc} = \Delta KE + \Delta PE_g$$

$$\Delta KE = KE_f - KE_i = \frac{1}{2}mv^2 - 0 = \frac{1}{2}mv^2$$

$$\Delta PE_g = PE_f - PE_i = 0 - mgh = -mgh$$

$$W_{nc} = F_k d \cos 180° = -F_k d$$

$$F_k = \mu_k N = \mu_k mg\cos\theta$$

$$d = \frac{h}{\sin\theta} \Rightarrow W_{nc} = -\mu_k mg\cos\theta \cdot \frac{h}{\sin\theta} = -\mu_k mgh\cot\theta$$

$$\Rightarrow -\mu_k \cancel{m}gh\cot\theta = \frac{1}{2}\cancel{m}v^2 - \cancel{m}gh$$

$$\Rightarrow 2gh(1-\mu_k\cot\theta) = v^2$$

$$\Rightarrow v = \sqrt{2gh(1-\mu_k\cot\theta)} = \sqrt{h}\,(3.77)$$

for $h = 20\,m$, $v = 16.8\,m/s$

$h = 10\,m$, $v = 11.9\,m/s$

$h = 30\,m$, $v = 20.6\,m/s$

⑧

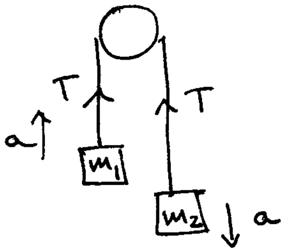
$$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2 \Rightarrow v = \sqrt{2gh}$$

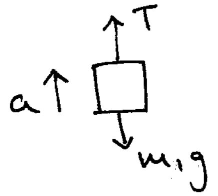
for $h = 10\,m$, $v = 14\,m/s$

$h = 20\,m$, $v = 19.8\,m/s$

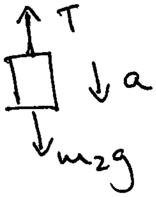
$h = 30\,m$, $v = 24.3\,m/s$

⑨





$\Rightarrow T - m_1 g = m_1 a$



$\Rightarrow T - m_2 g = -m_2 a$

$$\Rightarrow (m_2 - m_1) g = (m_1 + m_2) a$$

$$\Rightarrow a = \frac{(m_2 - m_1) g}{m_1 + m_2} \quad , \quad m_1 = 3 \text{ kg}$$

$$\Rightarrow a = \left(\frac{m_2 - 3}{3 + m_2}\right) 9.8$$

for $m_2 = 5$ kg , $a = 2.45$ m/s²

$m_2 = 10$ kg , $a = 5.3$ m/s²

$m_2 = 20$ kg , $a = 7.2$ m/s²

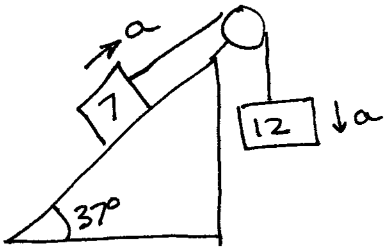
⑩ $d = v_{ox} t = 0.24 t$

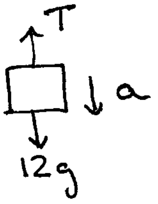
for $t = 0.3$s , $d = 0.072$ m

$t = 0.6$s , $d = 0.144$m

$t = 1.2$s , $d = 0.288$ m

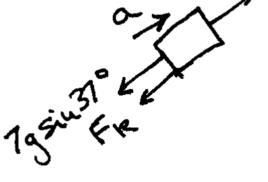
⑪





$T - 12g = -12a$

$\Rightarrow T + 12a = 117.6 \rightarrow ①$



$T - 7g\sin 37° - F_R = 7a$

$F_k = \mu_k \cdot 7g\cos 37°$

$\Rightarrow \quad T - 7a = 57.2 \rightarrow$ ②

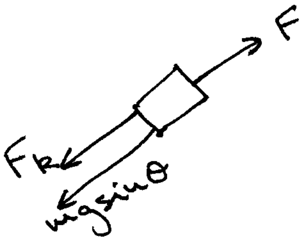
$\Rightarrow \quad 19a = 60.4 \Rightarrow a = 3.18\ m/s^2$

⑫ N is ⊥ d $\Rightarrow W = 0$

⑬ The speed of the plane relative to earth is less than the airspeed. Hence the plane will take longer than one hour to travel 200 miles.

⑭ $F = ma = 120\ N$

⑮



Total force $= 0$

$\Rightarrow F = F_k + mg\sin\theta$

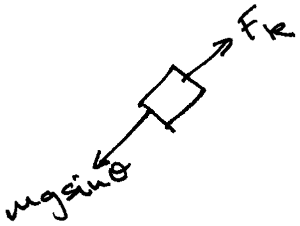
$= 10 + 50\sin 37° = 40\ N$

⑯ $F = ma = 6 \times 2 = 12\ N$

⑰ $W = Fd\cos\theta \quad , \quad [W] = [F][d][\cos\theta]$

$= MLT^{-2} . L . 1 = ML^2T^{-2}$

⑱



$$mg\sin\theta - F_k = ma$$

$$\Rightarrow \cancel{m}g\sin\theta - \mu_k \cancel{m}g\cos\theta = \cancel{m}a$$

$$\Rightarrow a = -0.477\ m/s^2$$

⑲ $$a = \frac{F}{m} = \frac{3.6\times10^4}{1.2\times10^4 + 0.6\times10^4} = 2\ m/s^2$$