Université d'Ottawa · University of Ottawa

Faculté des sciences Physique | Faculty of Science Physics

PHY1121A/PHY1121B

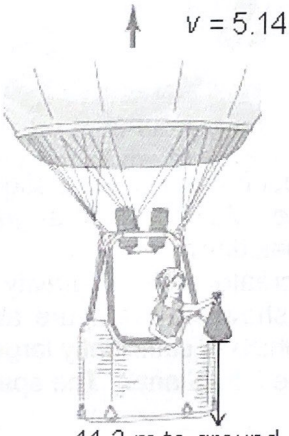
October 12, 2019
Mid-Term Examination 1

Dr. Zbigniew M. Stadnik

The answers should be entered carefully on a computer readable sheet using an HB pencil. When the exam time is over, you hand over only the computer sheet and keep this questionnaire for yourself.

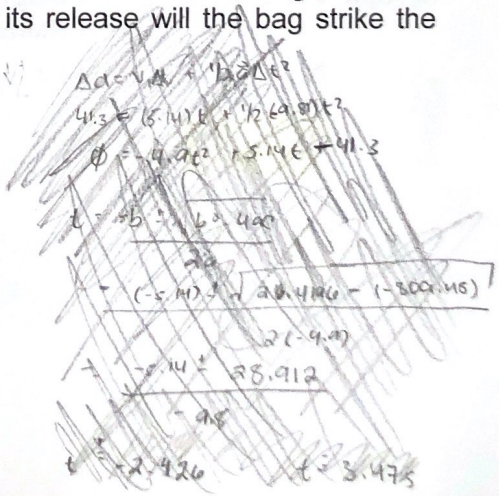
Cellular phones, unauthorized electronic devices or course notes (unless an open-book exam) are not allowed during this exam. Phones and devices must be turned off and put away in your bag. Do not keep them in your possession, such as in your pockets. If caught with such a device or document, the following may occur: you will be asked to leave immediately the exam and academic fraud allegations will be filed which may result in you obtaining a 0 (zero) for the exam.

1.



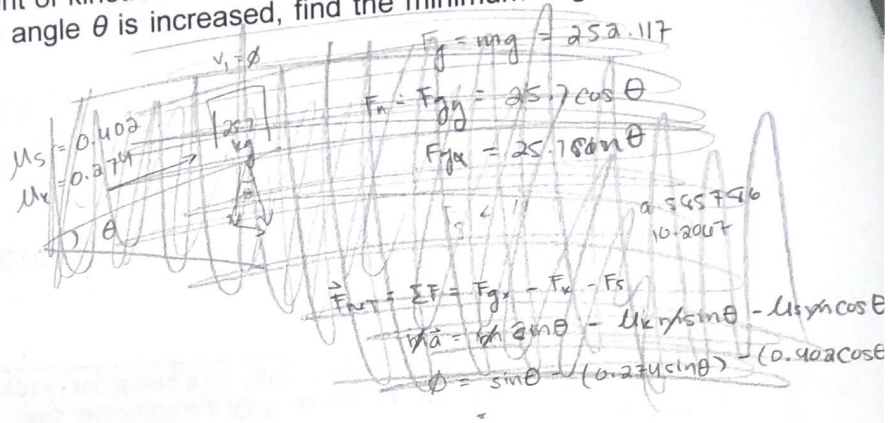
A hot-air balloonist, rising vertically with a constant velocity of magnitude $v = 5.14$ m/s, releases a sandbag at an instant when the balloon is at a height 41.3 m above the ground. How many seconds after its release will the bag strike the ground?

A) 3.41
B) 3.47
C) 3.52
D) 3.63
E) 3.74



2. A box of mass 25.7 kg rests on a loading ramp that makes an angle θ with the horizontal. The coefficient of kinetic friction is 0.274, and the coefficient of static friction is 0.402. As the angle θ is increased, find the minimum angle at which the box starts to slip.

A) 15.3°
B) 21.9°
C) 23.4°
D) 29.6°
E) 31.8°



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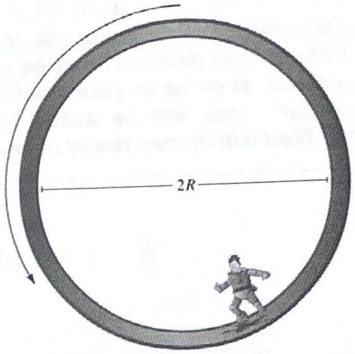


Artificial gravity is a must for any space station if humans are to live there for any extended length of time. Without artificial gravity, human growth is stunted and biological functions break down.

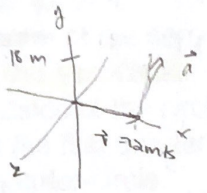
An effective way to create artificial gravity is through the use of a rotating enclosed cylinder, as shown in the figure above. Humans walk on the inside edge of the cylinder, which is sufficiently large (radius R) that its curvature is not readily noticeable to the inhabitants. The space station in the figure is not drawn to scale.

Once the space station is rotating at the necessary speed to create an artificial gravitational acceleration equal to the acceleration g at Earth's surface, how long it will take the space station to make one revolution. Express this time in terms of g and R.

A) $\pi\sqrt{\frac{R}{g}}$
B) $2\pi\sqrt{\frac{R}{g}}$
C) $3\pi\sqrt{\frac{R}{g}}$
D) $4\pi\sqrt{\frac{R}{g}}$
E) $6\pi\sqrt{\frac{R}{g}}$

4. At $t = 0$, a particle leaves the origin with a velocity of 12 m/s in the positive x direction and moves in the xy plane with a constant acceleration of $\mathbf{a} = (-2.0\hat{\mathbf{i}} + 4.0\hat{\mathbf{j}})$ m/s^2. At the instant the y coordinate of the particle is 18 m, what is the x coordinate of the particle?

A) 30 m
B) 21 m
C) 27 m
D) 24 m
E) 45 m



$\vec{a} = (-2.0\hat{i} + 4.0\hat{j})$ m/s^2

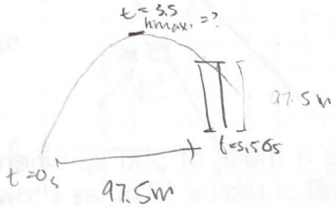
$-2.0\hat{i} + 4.0\hat{j} = km$

$4 + 16 = 20m$

$A = -8$ m/s

5. A baseball is hit at ground level. The ball is observed to reach its maximum height above ground level 3.00 s after being hit. And 2.50 s after reaching this maximum height, the ball is observed to barely clear a fence that is 97.5 m from where it was hit. How high is the fence?

A) 8.20 m
B) 15.8 m
C) 13.5 m
D) 11.0 m
E) 4.90 m



x	y
$t = 5.50$s	$t = 5.50$s
$\Delta d = 97.5$	$v_1 = 0$
$v = 17.23$	$\Delta d_y = ?$
	$v_2 = 17.23$
	~~$a = 9.8$ m/s^2~~

$\Delta d = \cancel{v_1 t} + \frac{1}{2} a t^2$

$= \frac{1}{2}(-9.81)(3.50)^2$

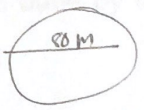
$=$

$\Delta d = \frac{1}{2}(v_1 + v_2)\, t$

$=$

6. A space station of diameter 80 m is turning about its axis at a constant rate. If the acceleration of the outer rim of the station is 2.5 m/s^2, what is the period of revolution of the space station?

A) 25 s
B) 19 s
C) 22 s
D) 28 s
E) 40 s



$\vec{a} = 2.5$ m/s^2

$T = \sqrt{\frac{4\pi^2 R}{a}}$

$=$

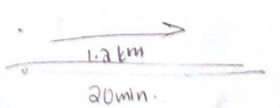
7. A river has a steady speed of 0.30 m/s. A student swims downstream a distance of 1.2 km and returns to the starting point. If the student swims with respect to the water at a constant speed and the downstream portion of the swim requires 20 minutes, how much time is required for the entire swim?

A) 50 minutes
B) 80 minutes
C) 90 minutes
D) 60 minutes
E) 70 minutes

$V_R = 0.30$ m/s $= 18$ m/min.

$V_S = 1$ m/s

$\Delta d = 1.2$ km



$V = \frac{\Delta d}{t} = \frac{1200}{1200} = 1$ m/s

$t = \frac{\Delta d}{V}$

$V_S = +0.3 + 1$ m/s

$= 1.3$ m/s or 0.7 m/s

8. The position of a particle moving along the x axis is given by $x = (6.0t^2 - 1.0t^3)$, where x is in meters and t in seconds. What is the position of the particle when it achieves its maximum speed in the positive x direction?

A) 24 m
B) 12 m
C) 32 m
D) 16 m
E) 2.0 m

$x' = 12t - 3t^2$

$0 = 12t - 3t^2 \div 3t(4+t)$

$3t = \frac{12}{3}$

$t = 4$

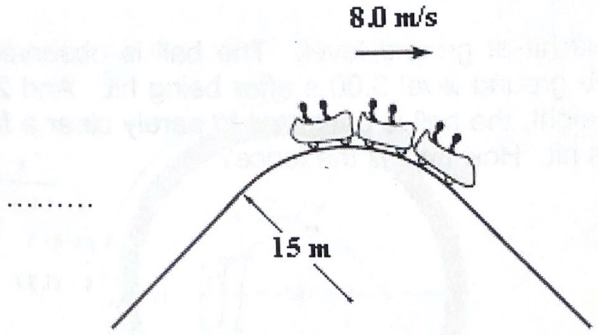
$x'' = 12 - 6t$

$t = 2$

$x = 6(4) - 1(8)$

$= 24 - 8$

9.



A roller-coaster car has a mass of 500 kg when fully loaded with passengers. The car passes over a hill of radius 15 m, as shown. At the top of the hill, the car has a speed of 8.0 m/s. What is the force of the track on the car at the top of the hill?

A) 7.0 kN up
B) 7.0 kN down
C) 2.8 kN down
D) 2.8 kN up
E) 5.6 kN down

$m = 500\text{kg}$
$r = 15\text{m}$
$v = 8\text{m/s}$

$f = \frac{mv^2}{R}$

$= \frac{(500)(8)^2}{15}$

$f =$

10. A skydiver of 75 kg mass has a terminal velocity of 60 m/s. At what speed is the resistive force on the skydiver half that when at terminal speed?

A) 15 m/s
B) 42 m/s
C) 49 m/s
D) 30 m/s
E) 36 m/s

$m = 75\text{kg}$
$v = 60\text{m/s}$

$\downarrow F_g = 735.75$

$\uparrow F_n = F_g$

$F_n = \phi \quad a = \phi$

$V = \frac{mg}{b}$

v

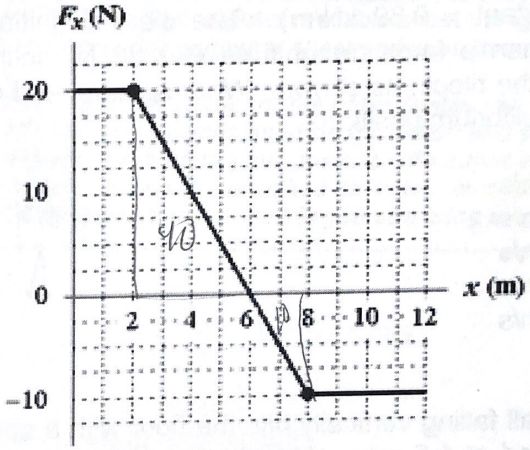
11. A car enters a level, unbanked semi-circular hairpin turn of 100 m radius at a speed of 28 m/s. The coefficient of friction between the tires and the road is $\mu = 0.80$. If the car maintains a constant speed of 28 m/s, it will

C

$r = 100\ m$
$v_i = 28\ m/s$
$\mu_k = 0.80$
$\mu mg = \frac{mv^2}{R}$
$7.84 = 7.84$

A) attempt to dig into the road surface.
B) tend to veer toward the center of the semicircle.
C) arrive safely at the end of the semicircle.
D) tend to veer toward the outside of the circle.
E) veer toward the center for the first quarter-circle, then veer toward the outside for the second quarter-circle.

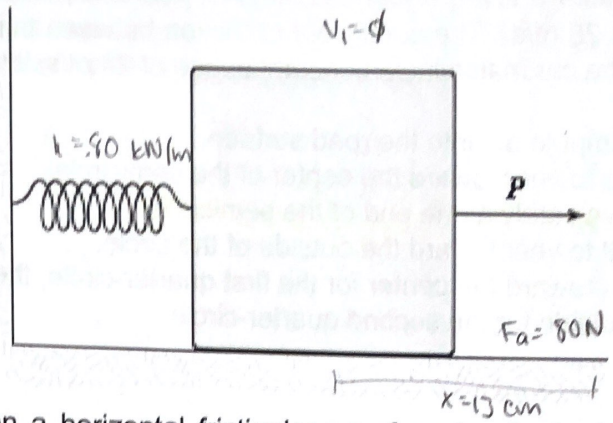
12.



An object moving along the x axis is acted upon by a force F_x that varies with position as shown. How much work is done by this force as the object moves from $x = 2.0$ m to $x = 8.0$ m ?

A) +30 J
B) −10 J
C) +10 J
D) −30 J
E) +40 J

13.



A 10-kg block on a horizontal frictionless surface is attached to a light spring (force constant = 0.80 kN/m). The block is initially at rest at its equilibrium position when a force (magnitude P = 80 N) acting parallel to the surface is applied to the block, as shown. What is the speed of the block when it is 13 cm from its equilibrium position?

$a = 8mk^2$

A) 0.52 m/s
B) 0.64 m/s
C) 0.77 m/s
D) 0.89 m/s
E) 0.85 m/s

$v = \sqrt{\frac{800}{10}}\ (80)$

$v_2^2 = v_1 + \vec{a}\,\Delta d$

14. A 2.4-kg ball falling vertically hits the floor with a speed of 2.5 m/s and rebounds with a speed of 1.5 m/s. What is the magnitude of the impulse exerted on the ball by the floor?

A) 9.6 N·s
B) 2.4 N·s
C) 6.4 N·s
D) 1.6 N·s
E) 1.0 N·s

$v = 2.8$ m/s ↓ 1.5 m/s

$J = \Delta p = (2.4)(1.5) - (2.4)(-2.5)$

$3.4 - 6$