103ex1

(THERE WERE NO PROBLEMS 1-5)

IN THESE PROBLEMS, I KEEP MORE DIGITS THAN I NEED AND ROUND OFF AT THE END, SO SOMETIMES THERE ARE SMALL DIFFERENCES BETWEEN MY ANSWERS AND THE CHOICES.

Physics 103 October 5, 2000 Exam 1 --- EXAM AAAAA

6. Using the dimensions for the variables given in the table,

Variable	Dimension
f	$\frac{1}{[T]}$
l	$[L]$
g	$\frac{[L]}{[T]^2}$

determine which one of the following expressions is correct.

A) $f = 2\pi l g$ $\longrightarrow$ $\frac{1}{[T]} \stackrel{?}{=} \frac{\cancel{[L]}}{\cancel{[L]}/[T]^2} = [T]^2$ NO

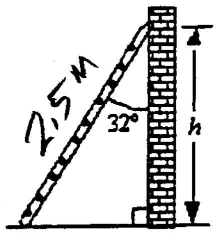
B) $2\pi f = \sqrt{\frac{g}{l}}$ $\longrightarrow$ $\frac{1}{[T]} \stackrel{?}{=} \left[\frac{\cancel{[L]}}{[T]^2} \times \frac{1}{\cancel{[L]}}\right]^{1/2}$ YES ✓

C) $f = \frac{g}{2\pi l}$ $\longrightarrow$ $\frac{1}{[T]} \stackrel{?}{=} \frac{\cancel{[L]}}{[T]^2} \times \frac{1}{\cancel{[L]}}$ NO

D) $2\pi f = \sqrt{\frac{l}{g}}$ $\longrightarrow$ $\frac{1}{[T]} \stackrel{?}{=} \left[\frac{\cancel{[L]}}{\cancel{[L]}/[T]^2}\right]^{1/2} = \left[[T]^2\right]^{1/2}$ NO

E) $f = 2\pi\sqrt{gl}$ $\longrightarrow$ $\frac{1}{[T]} \stackrel{?}{=} \left[\frac{[L]}{[T]^2} \times [L]\right]^{1/2} = \frac{[L]}{[T]}$ NO

7. A 2.5-m ladder leans against a wall and makes an angle with the wall of 32° as shown in the figure. What is the height h above the floor where the ladder makes contact with the wall?



$h = 2.5\,\text{m} \cos 32° = 2.12\,\text{m}$

A) 1.6 m
B) 1.9 m
C) 1.3 m
D) 2.4 m
E) 2.1 m

8. Three vectors **A, B,** and **C** add together to yield zero: **A + B + C = 0**. The vectors **A** and **C** point in *opposite* directions and their magnitudes are related by the expression : $A = 2C$. Which one of the following conclusions is correct?

A) **A** and **B** have equal magnitudes and point in opposite directions.
B) **B** and **C** have equal magnitudes and point in the same direction.
C) **B** and **C** have equal magnitudes and point in opposite directions.
D) **A** and **B** point in the same direction, but **A** has twice the magnitude of **B**.
E) **B** and **C** point in the same direction, but **C** has twice the magnitude of **B**.

$\vec{B}$ $\vec{C}$ $\vec{A}$

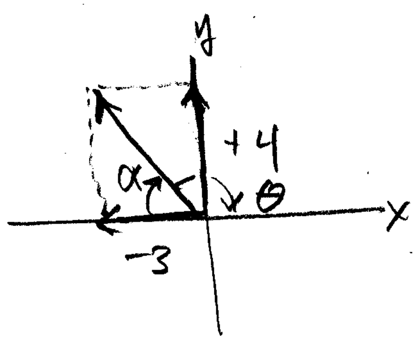
$|B| + |C| = |A|$

$2|C| = |A|$

$\Rightarrow 2|B| = |A|$

9. The x and y components of a displacement vector are –3.00 m and +4.00 m, respectively. What angle does this vector make with the positive x axis?

A) 127°
B) –53.0°
C) 53.0°
D) 233°
E) 37.0°

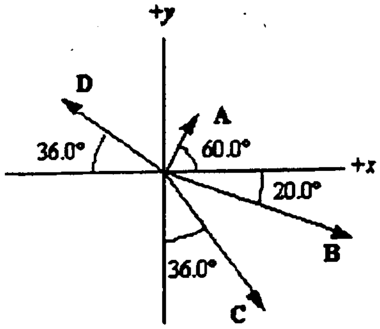


$\tan \alpha = 4/3$

$\alpha = 53°$

$\theta = 180° - \alpha = 127°$

10. Use the component method of vector addition to find the components of the resultant of the four displacements shown in the figure. The magnitudes of the displacements are: $A = 2.25$ cm, $B = 6.35$ cm, $C = 5.47$ cm, and $D = 4.19$ cm.



A: $A_x = 2{,}25 \cos 60° = 1{,}125$

$A_y = 2.25 \sin 60° = 1{,}948$

$B_x = 6{,}35 \cos 20° = 5{,}967$

$B_y = -6{,}35 \sin 20° = -2{,}172$

$C_x = 5{,}47 \sin 36° = 3.215$

$C_y = -5{,}47 \cos 36° = -4{,}425$

$D_x = -4{,}19 \cos 36° = -3.390$

$D_y = 4{,}19 \sin 36° = 2{,}463$

$A_x + B_x + C_x + D_x = 6{,}917$

$A_y + B_y + C_y + D_y = -2{,}186$

	x component	y component
A)	6.93 cm	–2.19 cm
B)	1.09 cm	–3.71 cm
C)	5.45 cm	–2.82 cm
D)	3.71 cm	–1.09 cm
E)	2.19 cm	–6.92 cm

11. A car starts from rest and accelerates at a constant rate in a straight line. In the *first* second the car covers a distance of 2.0 meters. How fast will the car be moving at the end of the *second* second?

A) 32 m/s
B) 4.0 m/s
C) 8.0 m/s
D) 16 m/s
E) 2.0 m/s

$x = x_0 + v_0 t + \frac{1}{2} a t^2 \quad x_0 = 0 \quad v_0 = 0$

$x = 2.0$ AT $t = 1$, SO $2.0 = \frac{1}{2} a (1)^2$

$\rightarrow a = 4.0\ m/s^2$. NOW $t = 2$, AND

$v = v_0 + at = 0 + 4.0(2) = 8.0\ m/s$

12. A race car has a speed of 80 m/s. At t = 0, the driver starts decelerating at –4 m/s². How far will the car travel before it stops?

A) 20 m
B) 1000 m
C) 400 m
D) 200 m
E) 800 m

$v = v_0 + at \quad v_0 = 80\ m/s$

$v = 0$

$a = -4\ m/s^2$

$0 = 80 + (-4)t$

$4t = 80$

$t = 20\ s$

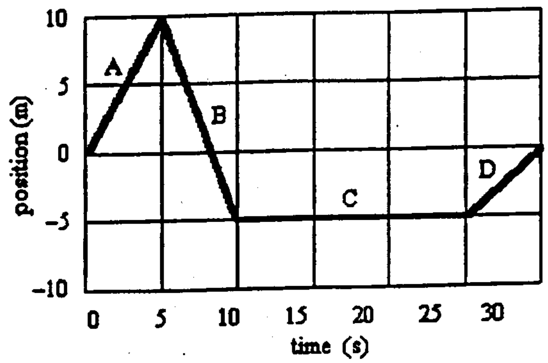
$x = x_0 + v_0 t + \frac{1}{2} a t^2 \quad x_0 = 0$

$x = 80 \cdot 20 + \frac{1}{2}(-4)\, 20^2$

$x = 1600 - 800 = 800\ m$

Use the following to answer question 13:

An object is moving along the x axis. The graph shows its **position** from the starting point as a function of **time**.



Various segments of the graph are identified by the letters A, B, C, and D.

13. During which interval(s) is the object *moving* in the negative x direction?
A) during interval B only
B) during intervals B and C
C) during intervals C and D
D) during intervals B and D
E) during intervals B, C, and D

MOVING IN NEGATIVE X DIRECTION MEANS X VS. t GRAPH MUST HAVE A NEGATIVE SLOPE, SINCE v IS THE SLOPE. ONLY IN B IS SLOPE NEGATIVE.

Use the following to answer question 14:

A tennis ball is shot vertically upward with an initial speed of 20.0 m/s from the surface of planet Krypton--a planet with no atmosphere. One second later, the ball has an instantaneous velocity in the upward direction of 15.0 m/s.

14. How long does it take the ball to reach its maximum height?
A) 4.0 s
B) 2.3 s
C) 8.0 s
D) 4.6 s
E) 2.0 s

$v_f = v_0 + at$ or $a = (v_f - v_0)/t$

$v_f = 15.0$ m/s $\quad v_0 = 20.0$ m/s

$t = 1$ s, so $a = \frac{15.0 - 20.0}{1} = -5.0$ m/s^2

FOR MAXIMUM HEIGHT, $v = 0$

$v = v_0 + at_{MAX} = 20.0 - 5.0\, t_{MAX} = 0$

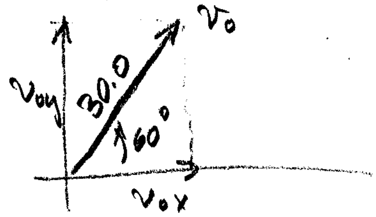
SO $t_{MAX} = 4.0$ s.

Use the following to answer question 15:

A projectile is fired at an angle of 60.0° above the horizontal with an initial speed of 30.0 m/s.

15. How long does it take the projectile to reach the highest point in its trajectory?

A) 1.5 s
B) 4.0 s
C) 2.7 s
D) 9.8 s
E) 6.2 s



$V_{oy} = 3.0 \sin 60° = 25.98$ M/S

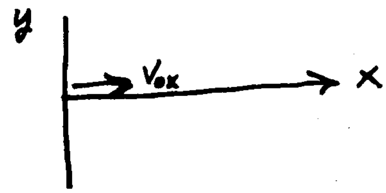
$v_y = 0$ AT HIGHEST POINT

$V_y = 0 = V_{oy} + at = 25.98 + (-9.8)t$

$t = 25.98/9.8 = 2.651$ S $\quad \frac{M/S}{M/S^2} = S$

16. A projectile is fired horizontally with an initial speed of 57 m/s. What are the horizontal and vertical components of its displacement 3.0 s after it is fired?

	horizontal	*vertical*
A)	210 m	44 m
B)	170 m	-44 m
C)	210 m	0 m
D)	44 m	29 m
E)	170 m	-29 m



HORIZONTAL COMPONENT IS 57 M/S

IT DOES NOT CHANGE SO

$x = x_0 + V_{ox} t = 0 + 57 \cdot 3.0 = 171$ M

VERTICAL COMPONENT STARTS AT ZERO AND ACCELERATES DOWNWARD DUE TO GRAVITY

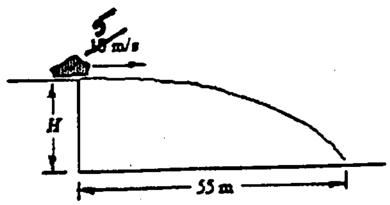
$y = y_0 + V_{oy} t + \frac{1}{2} a t^2$

$y = 0 + 0 \cdot t + \frac{1}{2}(-9.8)(3.0)^2 = -44.1$ M

$\cancel{\frac{M}{S^2} \times S^2}$

Use the following to answer questions 17-18:

A rock is kicked *horizontally* at a speed of 5 m/s from the edge of a cliff. The rock strikes the ground 55 m from the foot of the cliff of height H as suggested in the figure. Neglect air resistance.



$v_{0x} = 5$ m/s
DOESN'T CHANGE
$x = x_0 + v_0 t$
$55 \text{ m} = 0 + 5 \cdot t$
$t = 11 \text{ s}$

17. How long is the rock in the air?
A) 11.0 s
B) 22.0 s
C) 1.2 s
D) 3.4 s
E) 1.0 s

18. What is the approximate value of H, the height of the cliff?
A) 700 m
B) 595 m
C) 830 m
D) 540 m
E) 270 m

VERTICAL VELOCITY $v_{0y} = 0$

$y = -H = y_0 + v_{0y}t + \frac{1}{2}at^2$

$-H = 0 + 0 \cdot 11 + \frac{1}{2}(-9.8)(11)^2$

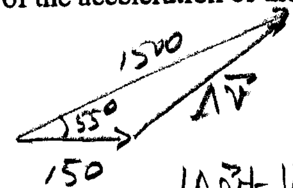
$-H = -593$ m

Use the following to answer question 19:

A spaceship is observed traveling in the positive x direction with a speed of 150 m/s when it begins accelerating at a constant rate. The spaceship is observed 25 s later traveling with an instantaneous velocity of 1500 m/s at an angle of 55° above the $+x$ axis.

19. What was the magnitude of the acceleration of the spaceship during the 25 seconds?

A) 57 m/s^2
B) 1.5 m/s^2
C) 28 m/s^2
D) 48 m/s^2
E) 7.3 m/s^2



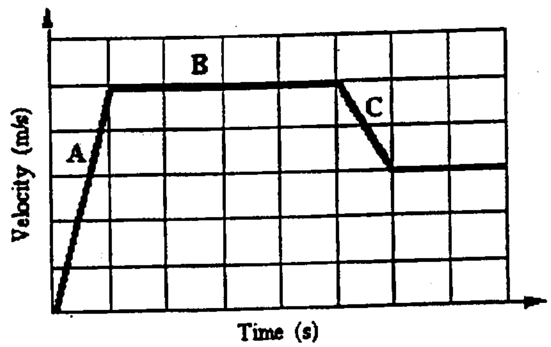
$\Delta v_y = 1500 \sin 55° = 1229$ m/s

$\Delta v_x = 1500 \cos 55° - 150 = 710$ m/s

$|\Delta\vec{v}| = \sqrt{\Delta v_x^2 + \Delta v_y^2} = [1229^2 + 710^2]^{1/2} = 1419$ m/s

$|\vec{a}| = |\Delta\vec{v}|/\Delta t = 1419/25 = 56.8$ m/s^2

20. The figure shows the **velocity** versus **time** curve for a car traveling along a straight line.



$F_{NET} = ma$ SO a HAS THE SAME SIGN AS F_{NET} AND $a = 0 \Rightarrow F_{NET} = 0$

Which of the following statements is false?

A) No net force acts on the car during interval B. → NO CHANGE IN $v \Rightarrow a = 0$ TRUE
B) Net forces act on the car during intervals A and C. → CHANGE IN $v \Rightarrow a \neq 0$ TRUE
C) Opposing forces may be acting on the car during interval B. → NO CHANGE IN $v \Rightarrow a \neq 0$ POSSIBLY TRUE BUT THEY DON'T CANCEL.
D) Opposing forces may be acting on the car during interval C. → COULD BE TRUE IF NET FORCE IS NEGATIVE, SO $a < 0$.
E) The magnitude of the net force acting during interval A is less than that during C.

→ NO, THE SLOPE OF LINE A HAS ~~GREATER~~ MAGNITUDE THAN SLOPE OF LINE C, SO

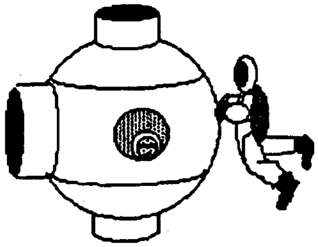
$|a_A| > |a_C|$

SINCE $F = ma$ AND m DOESN'T CHANGE,

$|F_A| > |F_C|$

Use the following to answer question 21:

In space, a 70.0-kg astronaut pushes to the left on a spacecraft with a force **F**.. (In orbit, both the astronaut and the spacecraft are weightless). The spacecraft has a total mass of 1.0×10^4 kg.



During the push, the astronaut accelerates to the right with an acceleration of 0.36 m/s^2.

21. Determine the magnitude of the acceleration of the spacecraft.
A) 3.97×10^{-4} m/s^2
B) 51.4 m/s^2
C) 0.36 m/s^2
D) 7.0×10^{-3} m/s^2
E) 2.5×10^{-3} m/s^2

SPACECRAFT FEELS FORCE F, ACCELERATES AT $a_{SPACECRAFT} = F/m_{SPACECRAFT} = F/1.0 \times 10^4 kg$

ASTRONAUT FEELS REACTION FORCE F, IN OPPOSITE DIRECTION (RIGHT), ACCELERATES AT

$a_{ASTRONAUT} = F/m_{ASTRONAUT}$; SO

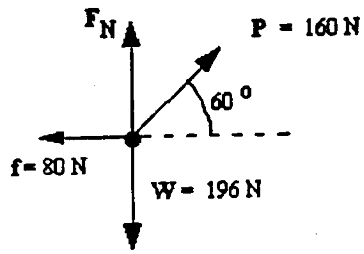
$0.36\ m/s^2 = F/70.0\ kg \Rightarrow F = 70.0 \times 0.36\ kg\ m/s^2$

$F = 25.2\ N$

THEREFORE $a_{SPACECRAFT} = 25.2\ N/1.0 \times 10^4\ kg = 2.52 \times 10^{-3}\ m/s^2$

Use the following to answer question 22:

A force **P** pulls on a crate of mass *m* on a rough surface. The figure shows the magnitudes and directions of the forces that act on the crate in this situation. **W** represents the weight of the crate. $\mathbf{F_N}$ represents the normal force on the crate, and **f** represents the frictional force.



F_N BALANCES THE DOWNWARD FORCE OF THE CRATE ON THE ROUGH SURFACE, WHICH IS THE WEIGHT OF THE CRATE LESS THE VERTICAL COMPONENT OF THE FORCE P.

22. What is the magnitude of $\mathbf{F_N}$, the normal force on the crate?

A) 57 N
B) 80 N
C) 196 N
D) 230 N
E) 160 N

$P_{VERTICAL} = 160\ N \times \sin 60° = 139\ N$

$F_N = 196 - 139 = 57\ N$

23. A boy pulls a sled of mass 5.0 kg with a rope that makes an 60.0° angle with respect to the horizontal surface of a frozen pond. The boy pulls on the rope with a force of 10.0 N; and the sled moves with <u>**constant velocity**</u>. What is the coefficient of friction between the sled and the ice?

A) 0.10
B) 0.18
C) 1.0
D) 0.12
E) 0.20

THE FREE BODY DIAGRAM IS JUST LIKE THE ONE IN PROBLEM 22, AND SINCE THERE IS NO ACCELERATION THE FRICTION f MUST BALANCE

$P_{HORIZONTAL} = 10.0\ N \times \cos 60°$

$f = 10.0\ N \cos 60° = 5.0\ N$

$f = \mu F_N$ SO NOW WE NEED TO FIND F_N. THAT WILL BE THE WEIGHT OF THE SLED LESS THE VERTICAL PART OF P, $F_N = mg - P \sin 60°$

$F_N = 5.0\,kg\,(9.8\ m/s^2) - 10.0 \sin 60°$

$F_N = 49 - 8.66 = 40.3\ N$

$f = \mu F_N$

so $\mu = f / F_N$

$\mu = 5.0 / 40.3$

$\mu = 0.123$