

EXAM VERSION DACEB

Physics 103 Fall 2001 Exam 1

BEFORE BEGINNING THE EXAM

Write and fill in your name, your 10-digit student ID number, and your section number (301 to 329) in the special codes boxes A, B, and C on the answer sheet.

Each exam has a five-letter code, such as ABCDE. Carefully enter this five-letter code as the first five "answers" on the answer sheet. For example, for exam ABCDE, number one on the answer sheet should be marked "A", number two "B", number three "C", and so on. Thus THE EXAM BEGINS WITH QUESTION NUMBER 6! Answer ALL 20 questions. Guessing is NOT penalized!

Don't spend too much time on any particular problem, but move on and come back to it later.

YOU MUST HAND IN THE EXAM TO YOUR DISCUSSION SECTION TA

YOU MAY ONLY USE PENCILS, A CALCULATOR, AND YOUR FORMULA SHEET FOR THE EXAM

MULTIPLE CHOICE

6. Note the expression: $y = x^2$. Which statement is most consistent with this expression?

- a. if y doubles, then x quadruples
- b. y is greater than x
- c. if x doubles, then y doubles
- d. if x doubles, then y quadruples
- e. x is greater than y

$$y = x^2 \quad \text{IF } x' = 2x$$

$$(x')^2 = (2x)^2 = 4x^2 = 4y$$

7. In mechanics, physicists use three basic quantities to derive additional quantities. Mass is one of the three quantities. What are the other two?

- a. length and time
- b. length and force
- c. velocity and time
- d. force and time
- e. power and force

8. A furlong is a distance of 220 yards. A fortnight is a time period of 2 weeks. A race horse is running at a speed of 5 yards per second. What is his speed in furlongs per fortnight?

- a. 6,221 furlongs/fortnight
- b. 27,491 furlongs/fortnight
- c. 1,324 furlongs/fortnight
- d. 2,749 furlongs/fortnight
- e. 13,674 furlongs/fortnight

$$5 \frac{\text{YD}}{\text{S}} \times \frac{1 \text{ FURLONG}}{220 \text{ YD}} \times \frac{3600 \text{ S}}{1 \text{ HR}} \times \frac{24 \text{ HR}}{1 \text{ DAY}} \times \frac{14 \text{ DAY}}{1 \text{ FORTNIGHT}} =$$

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9. The speed of a boat is often given in knots. If a speed of 5 knots were expressed in the SI system of units, the units would be:

a. m
 b. s
 c. m/s
 d. kg/s
 e. m/s²

10. For which value below is $x > x^3$?

a. $x = -1.0$
 b. $x = 0.5$
 c. $x = 1.0$
 d. $x = 1.5$
 e. $x = -0.5$

$$0.5 > (0.5)^3 = 0.125$$

11. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is the final velocity after ~~10~~ 11 s?

a. 5.1 m/s
 b. 1.8 m/s
 c. 4.0 m/s
 d. zero
 e. 3.2 m/s

$$x = x_0 + v_0 t + \frac{1}{2} a t^2 = 0 + 0 + \frac{1}{2} a (11)^2 = 28$$

$$a = 56/121 = 0.463 \text{ m/s}^2$$

$$v_f = v_0 + a t = 0 + 0.463 \cdot 11 = 5.09 \text{ m/s}$$

12. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is its acceleration?

a. 0.64 m/s²
 b. 0.21 m/s²
 c. 0.84 m/s²
 d. 0.78 m/s²
 e. 0.46 m/s²

SEE ABOVE ↑

13. A European sports car dealer claims that his product will accelerate at a constant rate from rest to a speed of 100 km/hr in 8 s. What is the speed after the first 5 s of acceleration?

a. 28.7 m/s
 b. 34.7 m/s
 c. 53.2 m/s
 d. 17.4 m/s
 e. 44.4 m/s

$$a = \frac{v_f - v_0}{t} = \frac{100 \text{ km/hr} - 0}{8 \text{ s}} = 12.5 \text{ km/hr} \cdot \text{s}$$

NOW AT 5 sec?

$$v_{5 \text{ sec}} = v_0 + a(5 \text{ s}) = 0 + 5 \text{ s} \times (12.5 \text{ km/hr} \cdot \text{s})$$

$$v_{5 \text{ sec}} = 62.5 \text{ km/hr} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ hr}}{3600 \text{ s}}$$

$$v_{5 \text{ sec}} = 17.36 \text{ m/s}$$

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14. Human reaction time is usually about 0.2 s. If your lab partner holds a ruler between your finger and thumb and releases it without warning, how far can you expect the ruler to fall before you catch it? At least:

- a. 16.0 cm
- b. 4.0 cm
- c. 7.2 cm
- d. 19.6 cm
- e. 9.8 cm

$$y = y_0 + v_{0y}t + \frac{1}{2}at^2 \quad a = -9.8 \quad v_{0y} = 0$$

$$t = 0.2 \quad y_0 = 0 \quad y = 0 + 0(0.2) + \frac{1}{2}(-9.8)(0.2)^2$$

$$y = -0.196 \text{ m} \quad (- \text{BECAUSE IT FELL IN } -y \text{ DIR.})$$

15. At the top of a cliff 100 m high, Raoul throws a rock upward with velocity 15 m/s. How much later should he drop a second rock from rest so both rocks arrive simultaneously at the bottom of the cliff? TIME FOR ROCK TO FALL (100M)

- a. 2.67 s
- b. 5.05 s
- c. 0.89 s
- d. 1.78 s
- e. 3.76 s

$$15 - 100 = \frac{1}{2}(-9.8)t^2 \Rightarrow t = 4.52 \text{ s, TIME FOR THROWN ROCK}$$

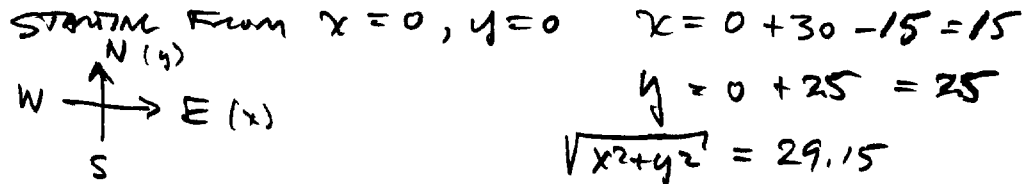
$$15 - 100 = 15t + \frac{1}{2}(-9.8)t^2 \text{ OR } 4.9t^2 - 15t - 100 = 0$$

USING QUADRATIC FORMULA $t = \frac{15 \pm \sqrt{15^2 + 4(4.9)(100)}}{2(4.9)}$

$$t = 6.30 \text{ s; } 6.30 - 4.52 = 1.78 \text{ s}$$

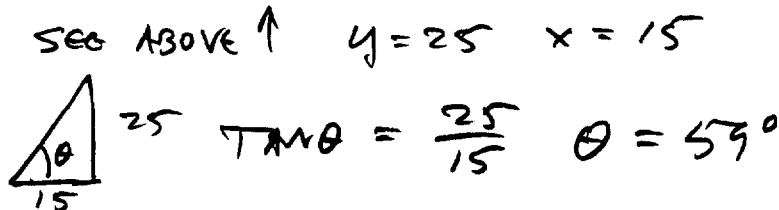
16. Arvin the Ant is on a picnic table. He travels 30 cm eastward, then 25 cm northward and finally 15 cm westward. What is the magnitude of Arvin's net displacement?

- a. 52 cm
- b. 70 cm
- c. 42 cm
- d. 29 cm
- e. 57 cm



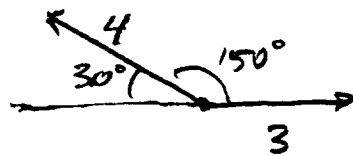
17. Arvin the Ant travels 30 cm eastward, then 25 cm northward and finally 15 cm westward. What is Arvin's directional displacement with respect to his original position?

- a. 29° N of W
- b. 59° N of E
- c. 59° N of W
- d. 77° N of E
- e. 29° N of E



18. Vector A is 3 units in length and points along the positive x-axis; vector B is 4 units in length and points along a direction 150° from the positive x-axis. What is the direction of the resultant with respect to the positive x-axis?

- a. 86°
- b. 77°
- c. 43°
- d. 103°
- e. 13°



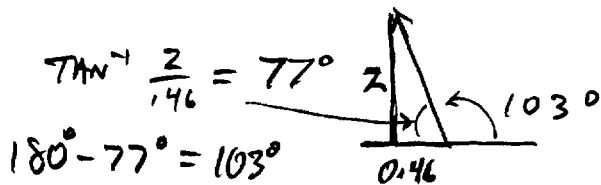
$$A_x = 3 \quad A_y = 0$$

$$B_x = -4 \cos 30 = -3.46$$

$$B_y = 4 \sin 30 = 2$$

$$(\text{RESULT.})_x = -0.46$$

$$(\text{RESULT.})_y = 2$$



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19. A ball is rolled off a table with an initial speed of 0.24 m/s. A stop watch measures the ball's trajectory time from table to the floor to be 0.3 s. What is the height of the table? ($g = 9.8 \text{ m/s}^2$ and air resistance is negligible)

- a. 0.55 m
 b. 0.44 m
 c. 0.33 m
 d. 0.22 m
 e. 0.11 m

ONLY NEED TIME TO FALL = 0.3 s

$$y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2 = \cancel{0} + \cancel{0}(0.3) + \frac{1}{2}(-9.8)(0.3)^2$$

$$y = 0.44 \text{ m}$$

20. A ball is rolled off a table with an initial speed of 0.24 m/s. A stop watch measures the ball's trajectory time from table to the floor to be 0.3 s. How far away from the table does the ball land? ($g = 9.8 \text{ m/s}^2$ and air resistance is negligible)

- a. 0.144 m
 b. 1.9 m
 c. 1.2 m
 d. 0.072 m
 e. 0.055 m

ONLY NEED HORIZONTAL VELOCITY & TIME

$$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2 = \cancel{0} + 0.24(0.3) + \frac{1}{2}\cancel{0}(0.3)^2$$

$$x = 0.072$$

21. An airplane of mass $1.2 \times 10^4 \text{ kg}$ tows a glider of mass $0.6 \times 10^4 \text{ kg}$. The airplane propellers provide a net forward thrust of $3.6 \times 10^4 \text{ N}$. What is the glider's acceleration?

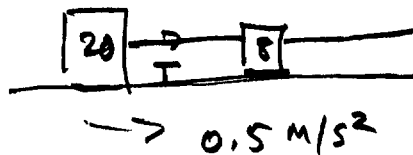
- a. 4.0 m/s²
 b. 9.8 m/s²
 c. 6.0 m/s²
 d. 3.0 m/s²
 e. 2.0 m/s²

PLANE AND GLIDER ACCELERATE TOGETHER

$$a = F/m = \frac{3.6 \times 10^4 \text{ N}}{(0.6 \times 10^4 + 1.2 \times 10^4) \text{ kg}} = 2.0 \text{ m/s}^2$$

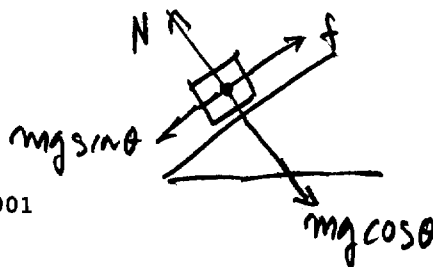
22. Two blocks of masses 20 kg and 8 kg are connected together by a light string and rest on a frictionless level surface. Attached to the 8 kg mass is another light string which a person uses to pull both blocks horizontally. If the two-block system accelerates at 0.5 m/s^2 , then what is the tension in the connecting string between the blocks?

- a. 5 N
 b. 4.0 N
 c. 10 N
 d. 6 N
 e. 14 N



THE ONLY FORCE ON THE 20 kg BLOCK IS THE TENSION T, SO

$$T = ma = 20 \text{ kg} \times 0.5 \text{ m/s}^2 = 10 \text{ N}$$



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CONSTANT SPEED \Rightarrow ZERO ACCELERATION

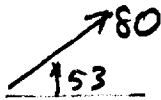
23. A 250 kg crate is placed on an adjustable inclined plane. If the crate slides down the incline with an acceleration of 0.7 m/s^2 when the incline angle is 25° , then what should the incline angle be for the crate to slide down the plane at constant speed? ($g = 9.8 \text{ m/s}^2$)

- a. 18°
- b. 29°
- c. 25°
- d. 21°
- e. 12°

DOWN THE PLANE: $a = F_{\text{NET}}/m = (mg \sin \theta - \mu_k mg \cos \theta)/m$
 $a = g(\sin \theta - \mu_k \cos \theta)$ SO $0.7 = 9.8(\sin 25^\circ - \mu_k \cos 25^\circ)$
 $\Rightarrow \mu_k = 0.387$; THEN $0 = 9.8(\sin \theta - 0.378 \cos \theta) \Rightarrow \theta = 21.2^\circ$

24. A man pulls a sled at a constant velocity across a horizontal snow surface. If a force of 80 N is being applied to the sled rope at an angle of 53° to the ground, what is the force of friction between sled and snow?

- a. 56 N
- b. 40 N
- c. 48 N
- d. 64 N
- e. 80 N

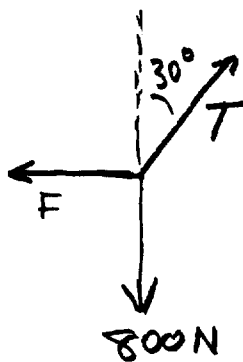


$F_x = 80 \cos 53 = 48.14$

FRICTION MUST BE EQUAL AND OPPOSITE FOR CONSTANT VELOCITY ($a=0 \Rightarrow F/m=0 \Rightarrow F=0$)

25. A trapeze artist, with swing, weighs 800 N; he is being held to one side by his partner so that the swing ropes make an angle of 30° with the vertical. In such a condition of static equilibrium what is the tension in the rope?

- a. 800 N
- b. 461 N
- c. 196 N
- d. 400 N
- e. 924 N



TO CANCEL THE 800N,

$T \cos 30 = 800$

$T = 924 \text{ N}$

(F CANCELS THE HORIZONTAL PART OF T:

$F = T \sin 30 = 462 \text{ N}$

THIS ANSWER WAS ALSO CONSIDERED CORRECT)