Instructor: *Profs. Acosta, Hagen, Hamlin*

PHYSICS DEPARTMENT

PHY 2048 Exam 1 February 15, 2019

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

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

YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.

DIRECTIONS

(1) **Code your test number on your answer sheet (use 76–80 for the 5-digit number)**. Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your student number on your answer sheet.

(2) Print your name on this sheet and sign it also.

(3) Do all scratch work anywhere on this exam that you like. 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 with scratch work most questions demand.

(4) **Blacken the circle of your intended answer completely, using a #2 pencil or <u>blue</u> or <u>black</u> ink**. Do not make any stray marks or the answer sheet may not read properly.

(5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing.

>>>>>>>>>**WHEN YOU FINISH** <<<<<<<<<

Hand in the answer sheet separately.

Use $g = 9.80\ \text{m/s}^2$

PHY2048 Exam 1 Formula Sheet

Vectors

$\vec{a} = a_x\hat{i} + a_y\hat{j} + a_z\hat{k}$ $\vec{b} = b_x\hat{i} + b_y\hat{j} + b_z\hat{k}$ Magnitudes: $|\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$ $|\vec{b}| = \sqrt{b_x^2 + b_y^2 + b_z^2}$

Scalar Product: $\vec{a}\cdot\vec{b} = a_xb_x + a_yb_y + a_zb_z$ Magnitude: $\vec{a}\cdot\vec{b} = |\vec{a}||\vec{b}|\cos\theta$ (θ = angle between $\vec{a}$ and $\vec{b}$)

Vector Product: $\vec{a}\times\vec{b} = (a_yb_z - a_zb_y)\hat{i} + (a_zb_x - a_xb_z)\hat{j} + (a_xb_y - a_yb_x)\hat{k}$

Magnitude: $|\vec{a}\times\vec{b}| = |\vec{a}||\vec{b}|\sin\theta$ (θ = angle between $\vec{a}$ and $\vec{b}$)

Motion

Displacement: $\Delta\vec{r} = \vec{r}(t_2) - \vec{r}(t_1)$

Average Velocity: $\vec{v}_{ave} = \dfrac{\Delta\vec{r}}{\Delta t} = \dfrac{\vec{r}(t_2) - \vec{r}(t_1)}{t_2 - t_1}$ Average Speed: s_{ave} = (total distance)/Δt

Instantaneous Velocity: $\vec{v} = \dfrac{d\vec{r}(t)}{dt}$ Relative Velocity: $\vec{v}_{AC} = \vec{v}_{AB} + \vec{v}_{BC}$

Average Acceleration: $\vec{a}_{ave} = \dfrac{\Delta\vec{v}}{\Delta t} = \dfrac{\vec{v}(t_2) - \vec{v}(t_1)}{t_2 - t_1}$ Instantaneous Acceleration: $\vec{a} = \dfrac{d\vec{v}}{dt} = \dfrac{d^2\vec{r}}{dt^2}$

Equations of Motion for Constant Acceleration

$\vec{v} = \vec{v}_0 + \vec{a}t$

$\vec{r} - \vec{r}_0 = \vec{v}_0t + \frac{1}{2}\vec{a}t^2$

$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$ (in each of 3 dim)

Newton's Laws

$\vec{F}_{net} = 0 \Leftrightarrow \vec{v}$ is a constant (Newton's First Law)

$\vec{F}_{net} = m\vec{a}$ (Newton's Second Law)

"Action = Reaction" (Newton's Third Law)

Force due to Gravity

Weight (near the surface of the Earth) = mg (**use g=9.8** m/s^2)

Magnitude of the Frictional Force

Static: $f_s \leq \mu_s F_N$ Kinetic: $f_k = \mu_k F_N$

Uniform Circular Motion (Radius R, Tangential Speed $v = R\omega$, Angular Velocity ω)

Centripetal Acceleration: $a = \dfrac{v^2}{R} = R\omega^2$ Period: $T = \dfrac{2\pi R}{v} = \dfrac{2\pi}{\omega}$

Quadratic Formula

If: $ax^2 + bx + c = 0$ Then: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Work (W), Mechanical Energy (E, Kinetic Energy (K)), Potential Energy (U)

Kinetic Energy: $K = \frac{1}{2}mv^2$ Work: $W = \displaystyle\int_{\vec{r}_1}^{\vec{r}_2} \vec{F}\cdot d\vec{r}$ When force is constant $W = \vec{F}\cdot\vec{d}$

Power: $P = \frac{dW}{dt} = \vec{F}\cdot\vec{v}$ Work-Energy Theorem: $K_f = K_i + W$ Work done by gravity: $W_g = -mg\Delta y$

Springs

Spring force (Hook's law): $F = -kx$ Work done by spring: $W_s = \dfrac{1}{2}kx_i^2 - \dfrac{1}{2}kx_f^2$

1. Three vectors are $\vec{a} = 3\hat{i} + \hat{j}$, $\vec{b} = \hat{i} + 3\hat{j}$, and $\vec{c} = \hat{i} + 2\hat{k}$. The angle between the directions of $\vec{c}$ and $\vec{a} \times \vec{b}$ is (in degrees)

   (1) 26.6 (2) 63.4 (3) 116.6 (4) 153.4 (5) 53.1

2. Three vectors are $\vec{a} = 3\hat{i} + \hat{j}$, $\vec{b} = \hat{i} + 3\hat{j}$, and $\vec{c} = 2\hat{i} + \hat{k}$. The angle between the directions of $\vec{c}$ and $\vec{a} \times \vec{b}$ is (in degrees)

   (1) 63.4 (2) 26.6 (3) 116.6 (4) 153.4 (5) 53.1

3. A car is driven a distance of 8.7 km east, then 4.1 km in a direction 35° north of east. Then the car is driven 7.2 km in a direction 25° south of west. Relative to the starting point, the final location of the car is

   (1) 7.1° south of east
   (2) 82.9° south of east
   (3) 30.3° south of west
   (4) 59.7° south of west
   (5) 1.1° north of east

4. A car is driven a distance of 8.7 km east, then 4.1 km in a direction 35° north of west. Then the car is driven 7.2 km in a direction 25° south of west. Relative to the starting point, the final location of the car is

   (1) 30.3° south of west
   (2) 7.1° south of east
   (3) 82.9° south of east
   (4) 59.7° south of west
   (5) 1.1° north of east

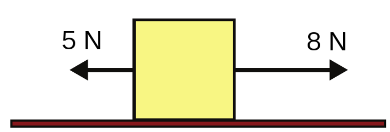
5. Vectors $\vec{A}, \vec{B}, \vec{C}$ are defined as $\vec{A} = 3\hat{i} + \hat{j}$, $\vec{B} = \hat{i} + 2\hat{j}$, and $\vec{C} = -\hat{i} + 3\hat{j}$ If $\vec{C} = p\vec{A} + q\vec{B}$, then the values of (p, q) are

   (1) (−1,2)
   (2) (2,−1)
   (3) (1,−4)
   (4) (1,−1)
   (5) Cannot be determined

6. An ancient army traveled at an average speed of 320 furlongs/fortnight. One furlong equals 0.125 miles and a fortnight is two weeks. What is the average speed of the army in miles per hour?

   (1) 0.12 (2) 15 (3) 2.9 (4) 0.24 (5) 7.6

7. The block shown moves with constant velocity on a horizontal surface. Two of the forces acting on the block are shown. A frictional force exerted by the surface is the only other horizontal force on the block. The frictional force is:

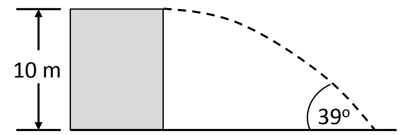


   (1) 3 N, to the left
   (2) 3 N, to the right
   (3) 13 N, to the left
   (4) 13 N, to the right
   (5) Need more information

8. A projectile is launched at an angle of 63° from the horizontal. The initial velocity of the projectile is 120 m/s. You may neglect air resistance. How many seconds after the initial launch does the projectile strike the ground?

   (1) 22 (2) 11 (3) 48 (4) 5.5 (5) 2.3

9. A rock is thrown horizontally off of a 10 m high cliff. The rock strikes the ground at an angle of 39°. You may neglect air resistance. With what speed (in m/s) was the rock thrown?

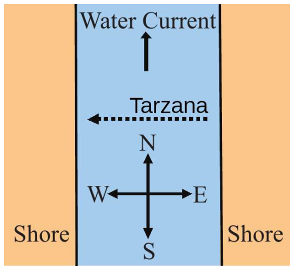


(1) 17
(2) 0.058
(3) 240
(4) 24
(5) 12

10. A 0.2 kg weight is tied to the end of a 0.6 m long string and spun in a vertical circle with uniform speed. The weight completes one full rotation every 0.8 seconds. What is the tension in the string (in N) when the weight is at the top of the loop?

(1) 5.4 (2) 9.8 (3) 0 (4) 47 (5) 2.8

11. A 120 m wide river flows from south to north at a speed of 0.3 m/s. Tarzana swims at a speed of 0.5 m/s (relative to the water). If Tarzana swims across the river so that she lands on the shore due west of her starting point, how long (in seconds) does it take her to cross?



(1) 300
(2) 240
(3) 400
(4) 210
(5) 600

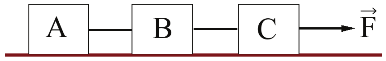
12. A spatially varying force is given by $F = a \cdot x^3$. The force is in newtons, and $a = 3$ N/m^3. How much work (in joules) does the force do when the object is displaced from $x = 1.8$ m to $x = 2.0$ m?

(1) 4.1 (2) 5.5 (3) 1.1 (4) 0.76 (5) 11

13. A block hangs from a spring with a spring constant of 100 N/m. The block causes the spring to stretch 12 cm from the relaxed position. What is the mass (in kg) of the block?

(1) 1.2 (2) 120 (3) 12 (4) 0.72 (5) 8.3

14. Three blocks (A,B,C), each having mass M, are connected by strings as shown in the picture. Block C is pulled to the right by a force that causes the entire system to accelerate. Neglecting friction, the magnitude of the tension in the string connecting blocks B and C is:

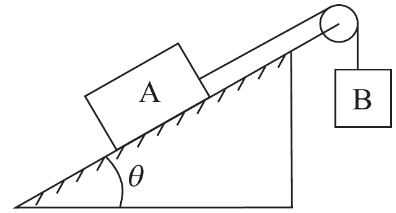


(1) $\frac{2F}{3}$ (2) $\frac{3F}{2}$ (3) $\frac{F}{3}$ (4) $3F$ (5) F

15. A car with a mass of 500 kg is traveling at 34 m/s. From the moment that the car begins to apply the brakes, to the moment that the car comes to a complete stop, it travels 90 m. Assuming constant acceleration, what was the magnitude of the acceleration (in m/s^2) of the car while braking?

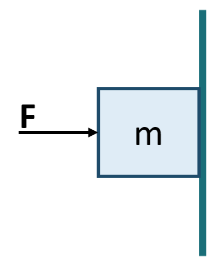
(1) 6.4 (2) 13 (3) 0.19 (4) 5.2 (5) 9.7

16. Block A, with a weight of 22 N, rests on a $\theta = 33°$ incline. An attached massless string is parallel to the incline and passes over a massless, frictionless pulley at the top. Block B, has a weight of 11 N. Both blocks are stationary (i.e., block A does not slide). What is the magnitude of the friction force (in newtons)?



(1) 0.98
(2) 11
(3) 33
(4) 0.54
(5) 2.1

17. A force $F = 31$ N presses a box of mass 1.5 kg against a wall. The static friction coefficient is $\mu_s = 0.6$ and the kinetic friction coefficient is $\mu_k = 0.3$. What is the magnitude of the net force on the box (in newtons)?

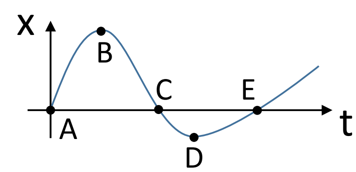


(1) 0
(2) 33
(3) 3.9
(4) 5.4
(5) 24

18. An object rotates about the origin ($x = 0$, $y = 0$) with uniform circular motion in the xy-plane. At some moment in time, the object is located at the position $x = 1$, $y = 0$. At that moment, the acceleration vector is pointed in the:

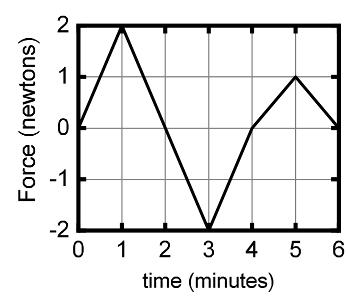
(1) $-x$ direction (2) $+x$ direction (3) $-y$ direction (4) $+y$ direction (5) $+z$ direction

19. The position of a particle as a function of time is shown in the figure. Which of the labeled points correspond to zero velocity?



(1) B and D only
(2) A, C, and E only
(3) A only
(4) None of the points
(5) Need more information

20. A time $t = 0$ an object is stationary ($v = 0$). The object is then subjected to a force, directed along the x-axis, that varies as shown in the figure. When (besides $t = 0$) is the velocity of the object zero?



(1) 4 minutes only
(2) 2, 4, and 6 minutes only
(3) 1, 3, and 5 minutes only
(4) 3 minutes only
(5) The velocity is only zero at $t = 0$.

21. The velocity of a particle (in m/s) is given by $\vec{v} = (4 + 10t^2)\hat{\imath} - (4t^3)\hat{\jmath}$, where t is in seconds. What is the magnitude of the acceleration (in m/s^2) at $t = 2$ seconds?

(1) 62 (2) 27 (3) 8 (4) 88 (5) 54

22. The velocity of a particle (in m/s) is given by $\vec{v} = (4 + 10t^2)\hat{\imath} - (3t^3)\hat{\jmath}$, where t is in seconds. What is the magnitude of the acceleration (in m/s^2) at $t = 2$ seconds?

(1) 54 (2) 17 (3) 20 (4) 76 (5) 62

23. The kinetic energy of an object increases from 4 joules to 5 joules (i.e., an increase of 25%). By what percent does the velocity of the object increase?

(1) 12 % (2) 25 % (3) 50 % (4) 9.5 % (5) Need to know the mass.

24. The kinetic energy of an object increases from 5 joules to 6 joules (i.e., an increase of 20%). By what percent does the velocity of the object increase?

(1) 9.5 % (2) 20 % (3) 40 % (4) 12 % (5) Need to know the mass.

Scratch paper

Scratch paper

FOLLOWING GROUPS OF QUESTIONS WILL BE SELECTED AS ONE GROUP FROM EACH TYPE
TYPE 1
Q# S 1
Q# S 2
TYPE 2
Q# S 3
Q# S 4
TYPE 3
Q# S 21
Q# S 22
TYPE 4
Q# S 23
Q# S 24