Instructor(s): *Matcheva/Yelton*

PHYSICS DEPARTMENT

PHY 2048 Exam 1 September 26, 2016

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.

(1) **Code your test number on your answer sheet (use lines 76–80 on the answer sheet for the 5-digit number)**. Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your UFID 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. **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) **Blacken the circle of your intended answer completely, 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. If you believe that no listed answer is correct, leave the form blank.**
(6) Hand in the answer sheet separately.

Use $g = 9.8$ m/s^2

PHY2048 Exam 1 Formula Sheet

Vectors

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

Scalar Product: $\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z$ $\qquad$ Magnitude: $\vec{a} \cdot \vec{b} = |\vec{a}||\vec{b}| \cos\theta$ (θ = angle between $\vec{a}$ and $\vec{b}$)

Vector Product: $\vec{a} \times \vec{b} = (a_y b_z - a_z b_y)\hat{i} + (a_z b_x - a_x b_z)\hat{j} + (a_x b_y - a_y b_x)\hat{k}$

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: $s_{ave} = (\text{total distance})/\Delta t$

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

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

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

$v_x^2 = v_{x0}^2 + 2a_x(x - x_0)$ (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: $f_s \leq \mu_s F_N$ $\qquad$ 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: $T = \dfrac{2\pi R}{v} = \dfrac{2\pi}{\omega}$

Projectile Motion

Range: $R = \dfrac{v_0^2 \sin(2\theta_0)}{g}$

Quadratic Formula

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

1. Remembering that there are 2.54 cm in an inch (and of course 36 inches in a yard), approximately how many cm^3 are there in a cubic yard (yd^3)?

   (1) 7.6×10^5 (2) 1.2×10^5 (3) 8.4×10^3 (4) 590 (5) 2.1×10^4

2. You drive 30 km north at 30 km/hr, followed by 40 km west at 40 km/hr. What, in km/hr, is the magnitude of your average velocity?

   (1) 25 (2) 35 (3) 50 (4) 70 (5) 10

3. The position of a particle as a function of time is given by the following formula:

$$\vec{r}(t) = (20t^2 + 10)\hat{\imath} + 5t^3\hat{\jmath}$$

   What is the magnitude of the acceleration at a time $t = 2$ s? (Assume SI units throughout.)

   (1) 72 (2) 100 (3) 50 (4) 98 (5) 110

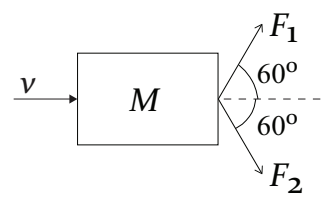
4. A catapult launches a ball from ground level with an initial velocity of $v = 40\,\mathrm{m/s}$ at 30° to the horizontal. What is its height above the ground level at the moment in its flight that its speed is least?

   (1) 20.4 m (2) 40.0 m (3) 34.6 m (4) 9.8 m (5) 25.2 m

5. You attempt to swim across a river 120 meters wide, and can swim at 2.6 m/s in still water. You set off aiming to arrive a point 50 meters downstream of your starting point. However, you fail to take into account the flow of the water, and because of this you land on the opposite bank 100 meters downstream of your starting point. What is the speed of the flow of water, in m/s?

   (1) 1.0 (2) 2.0 (3) 1.2 (4) 1.4 (5) 2.2

6. A block of mass $M = 2\,\mathrm{kg}$ moves with a uniform velocity of $v = 3\,\mathrm{m/s}$ in the direction as shown, while being acted on by 3 forces. Two of the forces (F_1 and F_2), each at 60° to the line of motion as shown in the figure, are of magnitude 2 Newtons. What is the magnitude of the third force?



   (1) 2 N (2) 4 N (3) 6 N (4) 0 N (5) 8 N

7. A large car, of mass M kg is broken down. To move it, a smaller car of mass $(M/2)$ kg pushes it in a straight line. At one moment in time, they both have a velocity of $v = 3\,\mathrm{m/s}$ and and acceleration of $a = 2\,\mathrm{m/s^2}$. If the force of the smaller car pushing on the larger one is 1000 N, what is the magnitude of force of the larger one on the smaller one?

   (1) 1000 N (2) 500 N (3) 2000 N (4) 0 N (5) You need to know the value of M.

8. A man is at the top of a tower, and drops a ball. One second later, he throws another ball down with a speed of 20.0 m/s. They hit the ground at the same time. How high (in meters) is the tower?

   (1) 10.7 (2) 19.6 (3) 25.2 (4) 15.4 (5) 8.9

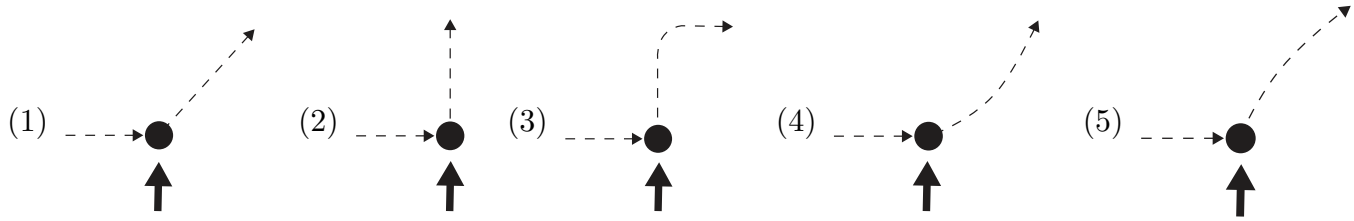
9. What is the value of $2\hat{\imath} \cdot (2\hat{\imath} \times 2\hat{\jmath})$?

(1) 0 (2) 8 (3) 2 (4) 4 (5) -8

10. An airplane is flying, horizontally, at a uniform velocity of $v = 200\,\mathrm{m/s}$ at a height of 200 meters above the ground. It drops an aid package to the ground below. What is the speed of the package when it hits the ground? (Answer in m/s and assume no air resistance.)

(1) 210 (2) 63 (3) 263 (4) 160 (5) 137

11. The figure shows an ice-hockey puck sliding at constant speed in a straight line from point A to point B on a frictionless, horizontal ice, observed from above. When the puck reaches point B it receives a short, sharp, horizontal kick in the direction of the large arrow. Which of the paths below would the puck follow most closely after receiving the kick?



12. You stand on a bathroom scale, and it reads 50 kg. You take it into the elevator, and at one instant it reads 40 kg. What can you deduce about the directions of the elevator's velocity and acceleration at that instant?

(1) v not known, a is down
(2) v is down, a is down
(3) v is down, a not known
(4) v is up, a is up
(5) v not known, a is up

13. A monkey of 10.0 kg starts from rest to climb a rope to reach a banana at a height of 5.0 meters above him. The rope will snap if its tension exceeds 110 N. What is the least amount of time the monkey could take to reach the banana without the rope breaking?

(1) 2.9 s (2) 35 s (3) 1.0 s (4) 8.3 s (5) 3.6 s

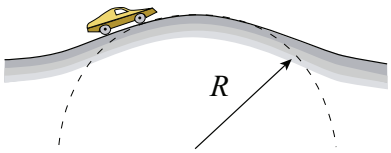
14. You try and whirl a 1.0 kg mass on a 1.0 meter long string, at constant speed in a horizontal circle. However, you find that the string is at an angle of 37 degrees below the horizontal because of gravity. How fast is the mass moving in m/s?

(1) 3.2 (2) 3.6 (3) 4.0 (4) 6.4 (5) 10.2

15. Two vectors, given in unit vector notation, are $\vec{A} = 5\hat{\imath} + 4\hat{\jmath} + 3\hat{k}$ and $\vec{B} = 3\hat{\imath} + 4\hat{\jmath} + 5\hat{k}$. What is $|\vec{A} - \vec{B}|$?

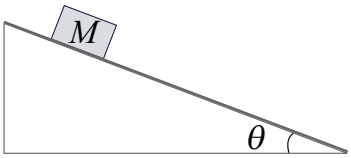
(1) 2.8 (2) 0 (3) 4.9 (4) 8.0 (5) 7.1

16. A car traveling at a speed of 20 m/s goes over a hill of radius R=50 m as shown. At the top of the hill, what upward force, in Newtons, does the car (seat + floor) exert on the 50 kg driver?



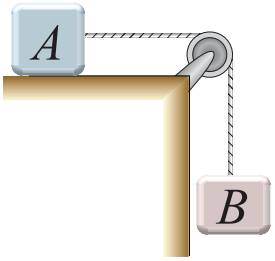
(1) 90 (2) 890 (3) 400 (4) 490 (5) 300

17. Because of friction, a block of mass M is stationary on a slope of angle θ as shown. If $M = 5.0\,\text{kg}$, $\theta = 20°$ and $\mu_s = 0.6$ for the mass/slope interface, what is the magnitude of the force of friction, in Newtons?



(1) 17 (2) 28 (3) 46 (4) 0 (5) 10

18. A block A with a mass of 3 kg rests on a horizontal table top. The coefficient of kinetic friction,$\mu_k = 0.5$. A horizontal string is attached to A and passes over a massless, frictionless pulley as shown, and block B with mass 2 kg hangs from it. Because of the pull of gravity, the masses accelerate. What is the Tension in the string (in Newtons)?



(1) 18 (2) 20 (3) 2.0 (4) 0 (5) 10

19. Starting at rest, a particle has an acceleration given by $a(t) = 6t + 1$, with a in m/s and t in seconds. How far, in meters, does it travel in the first two seconds?

(1) 10 (2) 16 (3) 64 (4) 52 (5) 26

20. A boy in a hot air balloon leans over the side and drops a stone. At the moment he drops it, the balloon has (taking up to be positive) $v = 2\,\text{m/s}$ and $a = 0.5\,\text{m/s}$. He notes that it takes 3 s for the stone to hit the ground. How high, in meters, was the balloon off the ground when he dropped the stone?

(1) 38 (2) 44 (3) 42 (4) 47 (5) 53

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