Instructor(s): *Matcheva/Yelton*

PHYSICS DEPARTMENT

PHY 2048 Exam 1 September 28, 2017

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

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PHY2048 Exam 1 Formula Sheet

Vectors

$\vec{a} = a_x\hat{i} + a_y\hat{j} + a_z\hat{k} \quad \vec{b} = b_x\hat{i} + b_y\hat{j} + b_z\hat{k}$ 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: $\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z$ 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: $f_s \leq \mu_s F_N$ 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: $ax^2 + bx + c = 0$ Then: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

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1. How many cubic centermeters (cm^3) are there in a cubic meter (m^3)?

   (1) 10^6 (2) 10^4 (3) 10^2 (4) 10^9 (5) 10^8

2. You jog 30 meters north at 1.5 m/s, then turn around and jog 40 meters south at 2.0 m/s. What, in m/s, is the magnitude of your average velocity?

   (1) 0.25 (2) 1.75 (3) 1.25 (4) 1.79 (5) 0.0

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

   $$\vec{r}(t) = (9t^2 + 12)\hat{i} + 6t^3\hat{j}$$

   At what time (t > 0) is the particle instantaneously moving at 45° to both the x and y axes?

   (1) 1.0 (2) 2.0 (3) 0.5 (4) 1.5 (5) 2.5

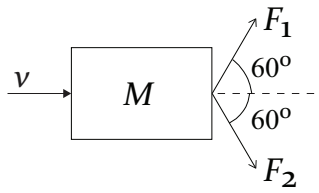
4. A kicker kicks a football off the ground when he is located 30 meters away (measured horizontally) from the goalposts. He kicks it at an angle of 30° above the horizontal. With what minimum speed (in m/s) does he need to kick the ball in order to get it over the crossbar (3 meters off the ground)?

   (1) 20.3 (2) 28.6 (3) 14.3 (4) 35.1 (5) 40.6

5. You swim at a speed of 4 m/s relative to still water. You swim across a 50 meter wide river that is flowing at 2 m/s, but head in a direction such that you actually travel at a right angle to the direction of the flow. How long does it take to cross the river, in s?

   (1) 14.4 (2) 12.5 (3) 9.9 (4) 8.3 (5) 18.3

6. A block of mass $M = 2\,\text{kg}$ moves with a uniform velocity of $v = 2\,\text{m/s}$ in the direction as shown, while being acted on by three 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 3 Newtons each. What is the magnitude of the third force?



   (1) 3 N (2) 4 N (3) 6 N (4) 0 N (5) 5.2 N

7. A man (mass=M) and his son (mass=m, where m=M/2), are both on frictionless ice. The man pushes using his hand against the back of the boy, with force F, putting both into motion. Which of the following will be true?

   (1) The boy imparts a force on his father, also of magnitude F
   (2) The boy imparts a force on his father of magnitude 2F
   (3) The boy imparts a force on his father of magnitude F/2
   (4) The boy imparts no force on his father
   (5) The boy imparts a force on his father of magnitude F/4

8. A man leans over the edge of a tower, 40 meters high and drops a ball over the edge. Simultaneously, his friend throws a ball straight up from ground level with a speed of 20 m/s, with such good aim that the two collide. How far off the ground (in m) are they when this happens?

   (1) 20.3 (2) 15.1 (3) 24.9 (4) 29.8 (5) 0.5

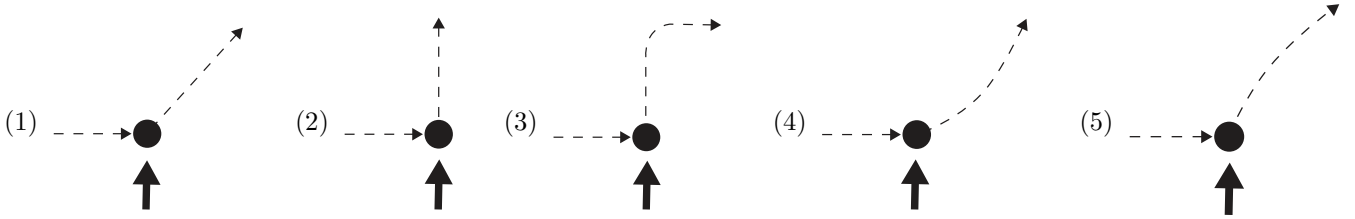
9. Calculate $(2\hat{i} \times (2\hat{i} \times 2\hat{j}))$?

(1) $-8\hat{j}$ (2) 0 (3) $8\hat{j}$ (4) $8\hat{i}$ (5) $-8\hat{i}$

10. A bus is moving at a uniform velocity of 4 m/s. A boy throws a ball out of the window horizontally, with a speed of 4 m/s, at a right angle to the bus in the rest frame of the bus and starting at 2 meters above the ground. How fast (in m/s) will it be traveling (in the earth's rest frame), when it hits the ground?

(1) 8.4 (2) 10.2 (3) 7.4 (4) 5.7 (5) 6.3

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 have a mass of 40 kg. You stand on a bathroom scale in an elevator which is moving with a velocity given $v = 8t - 4t^2$, where up is the positive direction, v is in m/s and t is in seconds. At $t = 1$ second, what will the bathroom scale read in kg?

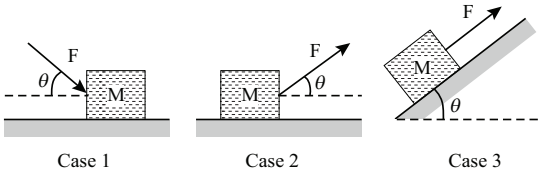
(1) 40 (2) 56 (3) 48 (4) 32 (5) 24

13. An amusement park ride consists of a car, moving in a vertical circle at a uniform speed of 5.0 m/s, on the end of a strong rigid rod of negligible mass. The combined mass of the car and rider is 200 kg, and the radius of the circle is 10.0 meters. At the bottom of the circle, what is the magnitude of the force exerted on the car by the rod?

(1) 2460 N (2) 500 N (3) 1460 N (4) 1960 N (5) 5000 N

14. In which case will the magnitude of the normal force on the block be equal to $(Mg + F\sin\theta)$?

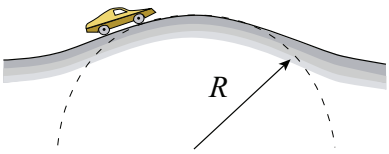
(1) case 1 only
(2) case 2 only
(3) both cases 1 and 2
(4) both cases 2 and 3
(5) cases 1, 2, and 3



15. Two vectors, given in unit vector notation, are $\vec{A} = 2\hat{i} + 3\hat{j} + 4\hat{k}$ and $\vec{B} = 4\hat{i} + 3\hat{j} + 2\hat{k}$. What is $|\vec{A} + \vec{B}|$?

(1) 10.3 (2) 108.0 (3) 8.4 (4) 6.0 (5) 18.0

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 is the net force, in Newtons, on the 50 kg driver?

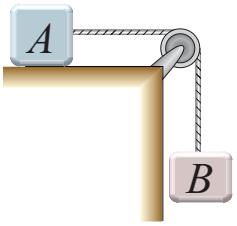


(1) 400 (2) 890 (3) 90 (4) 490 (5) 300

17. A block of mass 2 kg is at rest on a flat plane and the coefficients of static and kinetic friction are $\mu_s = 0.7$ and $\mu_k = 0.6$. A constant force of 10 N is then applied to the block in the horizontal direction. A short time after this force starts to be applied, what is the value of the force of friction?

(1) 10 N (2) 14 N (3) 12 N (4) 7 N (5) 22 N

18. A block A with a mass of 6 kg rests on a horizontal table top. The coefficient of kinetic friction is $\mu_k = 0.6$. A horizontal string is attached to A and passes over a massless, frictionless pulley as shown, and block B with mass 8 kg hangs from it. Because of the pull of gravity, the masses accelerate. What is the magnitude of this acceleration, in m/s^2?



(1) 3.1 (2) 1.4 (3) 8.1 (4) 7.4 (5) 2.5

19. A particle has a velocity in the x-direction given by $v(t) = A + Bt + Ct^2$, with t in seconds and v in m/s, A = 1.0 m/s, B = 1.0 m/s^2 and C = 1.0 m/s^3. How far, in meters, does it travel between t = 0 and t = 2 s?

(1) 6.7 (2) 13 (3) 1.8 (4) 3.0 (5) 8.0

20. On a sadistic fairground ride, a person is instantaneously moving with v = +5 m/s and a = +9.8 m/s^2, where up is taken as the positive direction. At this moment she releases a ball. Just after the release of the ball, the velocity and acceleration of the ball are (in the earth's rest frame):

(1) 5 m/s, −9.8 m/s^2 (2) 5 m/s, +9.8 m/s^2 (3) 0 m/s, −9.8 m/s^2 (4) 5 m/s, 0 m/s^2 (5) 0 m/s, 0 m/s^2