Last Name:_____First Name_____ID_____
Discussion Section:_____Discussion TA Name:_____

Instructions—

This is a closed book exam. You have ninety (90) minutes to complete it.

1. Use a #2 pencil; do **not** use a mechanical pencil or a pen. Fill in completely (until there is no white space visible) the circle for each intended input – both on the identification side of your answer sheet and on the side on which you mark your answers. If you decide to change an answer, erase vigorously; the scanner sometimes registers incompletely erased marks as intended answers; this can adversely affect your grade. Light marks or marks extending outside the circle may be read improperly by the scanner.

2. Print your last name in the **YOUR LAST NAME** boxes on your answer sheet and print the first letter of your first name in the **FIRST NAME INI** box. Mark (as described above) the corresponding circle below each of these letters.

3. Print your NetID in the **NETWORK ID** boxes, and then mark the corresponding circle below each of the letters or numerals. Note that there are different circles for the letter "I" and the numeral "1" and for the letter "O" and the numeral "0". **Do not** mark the hyphen circle at the bottom of any of these columns.

4. You may find the version of **this Exam Booklet at the top of page 2**. Mark the **version** circle in the **TEST FORM** box near the bottom right on the face of your answer sheet. **DO THIS NOW!**

5. Stop **now** and double-check that you have bubbled-in all the information requested in 2 through 4 above and that your marks meet the criteria in 1 above. Check that you do not have more than one circle marked in any of the columns.

6. Do **not** write in or mark any of the circles in the STUDENT NUMBER or SECTION boxes.

7. On the **SECTION** *line*, print your **DISCUSSION SECTION**. (You need not fill in the COURSE or INSTRUCTOR lines.)

8. Sign **(DO NOT PRINT)** your name on the **STUDENT SIGNATURE** *line*.

Before starting work, check to make sure that your test booklet is complete. You should have 11 ***numbered pages*** *plus two Formula Sheets.*

Academic Integrity—**Giving assistance to or receiving assistance from another student or using unauthorized materials during a University Examination can be grounds for disciplinary action, up to and including dismissal from the University.**

This Exam Booklet is Version A. Mark the **A** circle in the **TEST FORM** box near the bottom right on the face of your answer sheet. **DO THIS NOW!**

Exam Grading Policy—
The exam is worth a total of 110 points, and is composed of three types of questions:

MC5: *multiple-choice-five-answer questions, each worth 6 points.*
Partial credit will be granted as follows.
(a) If you mark only one answer and it is the correct answer,
you earn **6** points.
(b) If you mark *two* answers, one of which is the correct answer,
you earn **3** points.
(c) If you mark *three* answers, one of which is the correct answer, you earn **2** points.
(d) If you mark no answers, or more than *three*, you earn 0 points.

MC3: *multiple-choice-three-answer questions, each worth 3 points.*
No partial credit.
(a) If you mark only one answer and it is the correct answer,
you earn **3** points.
(b) If you mark a wrong answer or no answers, you earn **0** points.

TF: *true-false questions, each worth 2 points.*
No partial credit.

(a) If you mark only one answer and it is the correct answer, you earn **2** points.
(b) If you mark the wrong answer or neither answer, you earn **0** points.

Unless told otherwise, you should assume that the acceleration of gravity near the surface of the earth is 9.8 m/s^2 *downward and ignore any effects due to air resistance.*

The following 3 questions concern related physical situations:

A person is holding a soccer ball at 1.5 meter above the ground. Please ignore air resistance and the diameter of the soccer ball for these problems.

1. If she lets go of the ball so that it can fall freely due to gravity ($g=9.8\ m/s^2$), how long will it take for the ball to hit the ground?

   (a.) 0.55 s
   b. 0.66 s
   c. 0.77 s
   d. 0.88 s
   e. 0.99 s

$$y = -\frac{1}{2} g t^2$$

$$t = \sqrt{\frac{2|y|}{g}}$$

$$= \sqrt{\frac{2 \times 1.5\ m}{9.8\ m/s^2}} = 0.55\ s$$

2. If instead she throws the ball horizontally at the speed of 10 m/s, how would your answer to the previous question change?

   a. It will take longer for the ball to hit the ground.
   (b.) It will take the same amount of time.
   c. It will take shorter for the ball to hit the ground.

3. If she throws the ball straight up, it takes 2 seconds for the ball to come back to the initial height. What is the speed with which she threw the ball up?

   a. 10.2 m/s
   (b.) 9.8 m/s
   c. 8.5 m/s
   d. 7.2 m/s
   e. 6.7 m/ s

$$v_f = v_i - g t \qquad v_i = -v_f$$

$$2 v_i = g t$$

$$v_i = \frac{1}{2} g t = \frac{1}{2} 9.8\ m/s^2 \times 2\ s$$

$$= 9.8\ m/s$$

The following 2 questions concern the same physical situation:

A 90 kg man steps onto an elevator. While riding in the elevator, he notices that his apparent weight is 800 N.

4. What do you know about the direction the elevator is moving (its velocity)?

a. up
b. down
(c.) Not enough information

$W = mg = 90\ kg \times 9.8\ m/s^2$
$= 882\ N$

5. What is the acceleration of the elevator in the upward direction?

(a.) $a = -0.91\ m/s^2$
b. $a = 0.91\ m/s^2$
c. $a = 0\ m/s^2$
d. $a = -9.8\ m/s^2$
e. $a = -8.89\ m/s^2$

$N - mg = ma$

$a = \frac{N}{m} - g$

$= \frac{800\ N}{90\ kg} - 9.8\ m/s^2 = -0.91\ m/s^2$

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6. A car traveling on a horizontal road with the speed of 72 km/h can stop within 80 m when the driver uses anti-lock brakes, which means that the car brakes without skidding. What is the magnitude of the acceleration of the car? Assume the mass of the car is 1.2 x 10^3 kg.

a. $9.8\ m/s^2$
b. $5.0\ m/s^2$
c. $4.5\ m/s^2$
(d.) $2.5\ m/s^2$
e. $1.0\ m/s^2$

$v_f^2 = v_i^2 + 2a\Delta x$ ($v_f = 0$)

$v_i^2 = 2a\Delta x$

$a = \frac{v_i^2}{2\Delta x} = \frac{(72\ km/hr)^2}{2 \times 80\ m} = \frac{(20\ m/s)^2}{2 \times 80\ m}$

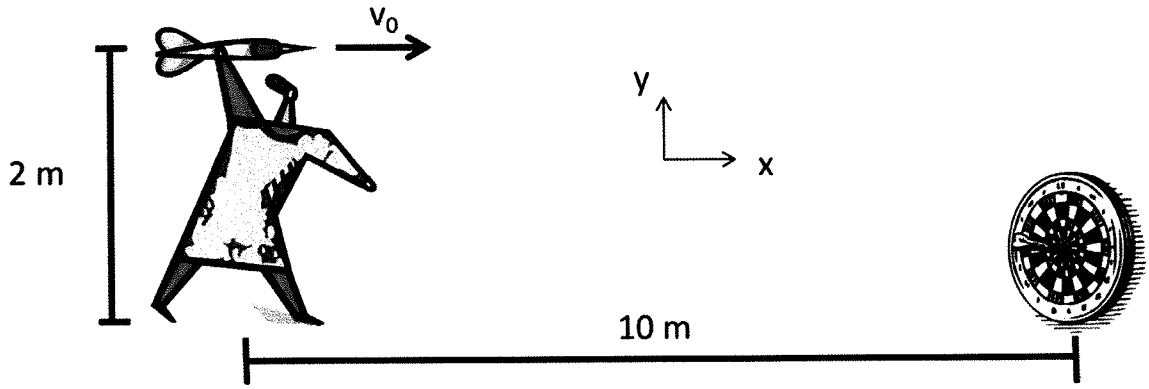
$= 2.5\ m/s^2$

$72\ km/hr = 72 \times 10^3\ m/3600\ s$

$= 20\ m/s$

The following 2 questions concern the same physical situation:

A person is throwing a dart from a height of 2 m relative to the ground and with the initial velocity of v_0 horizontally (i.e. in the positive x direction). The dart hits the bull's eye of the dart board 0.25 second later. Please ignore air resistance. The drawing is NOT to scale.



7. What is the magnitude of the initial velocity v_0?

a. 20 m/s
b. 30 m/s
(c.) 40 m/s
d. 50 m/s
e. 60 m/s

$\Delta x = v_0 t$

$v_0 = \frac{\Delta x}{t} = \frac{10\,m}{0.25\,s} = 40\ m/s$

8. What is the height of the bull's eye relative to the ground?

a. 2.0 m
(b.) 1.7 m
c. 1.5 m
d. 1.3 m
e. 0.5 m

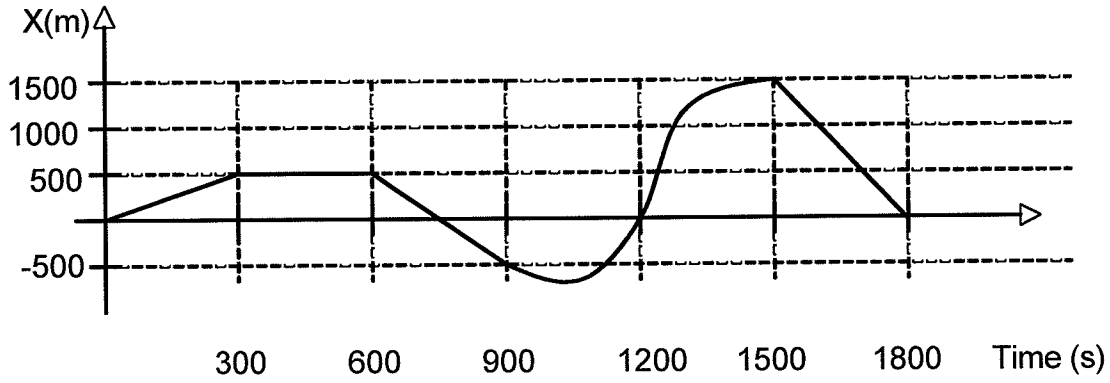
$y = y_0 + v_{0y}^{=0} t - \frac{1}{2} g t^2$

$y = 2m - \frac{1}{2}\ 9.8\ m/s^2\ (0.25\,s)^2$

$= 1.69\ m$

The following 2 questions concern the same physical situation:

Melissa and her dog took a walk along a straight path. The graph below represents their displacement from the start of the path, at x=0, as a function of time.



9. Which of the following statements is **NOT** true:

a. v(120 s) = 1.67 m/s
b. v(750 s) = -3.33 m/s
c. Over the 1800 s interval between t=0 and t=1800 s, $v_{average}$ = 0 m/s.
(d.) v(1200 s) = 0.00 m/s
e. v(1560 s) = -5.00 m/s

10. The acceleration is always zero between 600 s and 900 s.

(a.) true
b. false

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11. Physicists often look at equations from a dimensional point of view, assigning each variable in the equation powers of L=length, M=mass, and T=time. If a and g, represent accelerations, they have dimensions of $[LT^{-2}]$. Since F=ma, force has dimensions of $[M\,LT^{-2}]$. The left hand and right hand side of any equations has to have the same dimension.

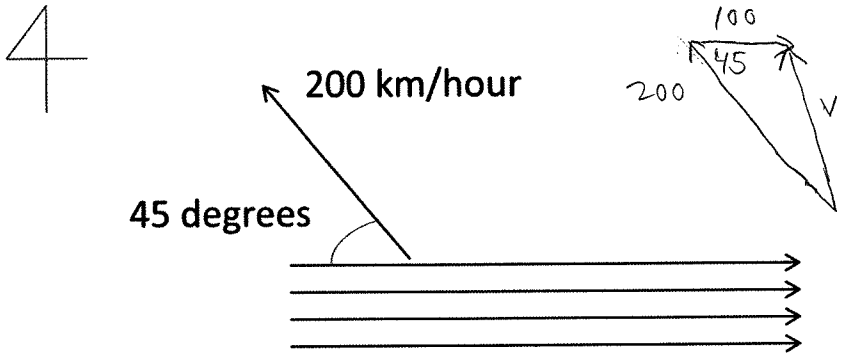
Suppose the buoyancy of a boat is given by the formula $F=\rho g W$, where ρ is the mass per unit volume, g is the acceleration of gravity and F is a force. What are the dimensions of W?

a. [L/M]
(b.) $[L^3]$
c. [L]

$F = \rho g W$

$\Rightarrow W = \frac{F}{\rho g} = \frac{[kg\ m/s^2]}{[kg/m^3 \times m/s^2]} = [m^3] = [L^3]$

12. A small airplane is flying due northwest at the speed of 200 km/hour making an angle of 45 degrees relative to the air. The wind blows to the east at the speed of 100 km/hour. What is the magnitude of the airplane's velocity relative to the ground?



Law of cosines:

$V^2 = (200)^2 + (100)^2 - 2(200)(100)\cos 45$

$\Rightarrow V = 147 \text{ km/hr}$

a. 280 km/hour
b. 180 km/hour
c. 200 km/hour
d. 249 km/hour
(e.) 147 km/hour

13. Harry and Hermione are floating in space wearing spacesuits. We can ignore gravitational forces due to other objects in this problem. Starting from rest, Harry pushes Hermione and as a result, Hermione starts to move in one direction with the initial acceleration of 5 m/s^2. What is the magnitude of initial acceleration of Harry if Harry weights 70 kg and Hermione 45 kg?

a. 5 m/s^2
b. 7.3 m/s^2
(c.) 3.2 m/s^2

Her: $F = ma = 45 \text{ kg} \times 5 \text{ m/s}^2 = 225 \text{ N}$

Har: $F = ma \Rightarrow a = \frac{F}{m} = \frac{225 \text{ N}}{70 \text{ kg}} = 3.21 \text{ m/s}^2$

14. A DVD player is spinning the disc an angular velocity of 30 radians/second. A person presses the stop button and the disc comes to rest after spinning an additional 270 radians. Assume constant acceleration. What is the magnitude of the angular acceleration of the disc after the stop button is pressed?

a. 1.0 radians/ s^2
(b.) 1.67 radians/s^2
c. 2.93 radians/s^2
d. 9.18 radians/s^2
e. 10.74 radians/s^2

$\omega_f^2 = \omega_i^2 - 2\alpha\Delta\theta$ ($\omega_f = 0$)

$\omega_i^2 = 2\alpha\Delta\theta$

$\alpha = \frac{\omega_i^2}{2\Delta\theta} = \frac{(30 \text{ rad/sec})^2}{2 \times 270 \text{ rad}} = 1.67 \text{ rad/s}^2$

The following 2 questions concern the same physical situations

A microcentrifuge spins a 0.18 kg sample that is 0.15 m from its axis at an angular velocity of 60 radians per second.

15. What is the speed of the sample in the centrifuge?

a. 1.6 m/s
b. 4.5 m/s
c. 6.8 m/s
(d.) 9.0 m/s
e. 11.8 m/s

$v = \omega R$
$= 60\ rad/s \times 0.15\ m$
$= 9\ m/s$

16. What is the direction of the net force on the sample in the centrifuge?

(a.) inward (toward the axis)
b. outward (away from the axis)
c. along the direction of motion of the sample

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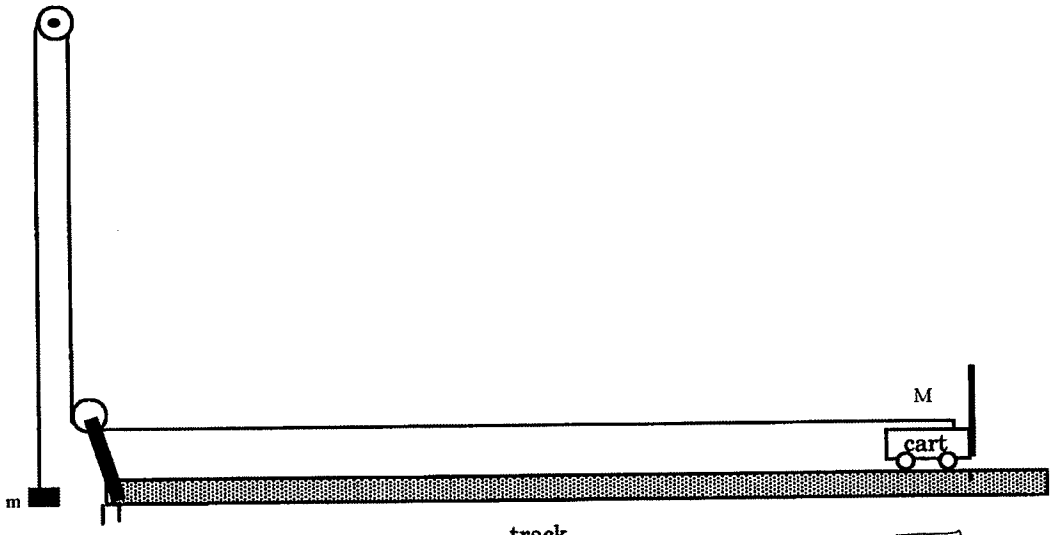
17. A boy pulls a sled across a frozen lake from rest to a final velocity of 4 miles per hour. The kinetic friction coefficient between the sled and the ice is $\mu_k = 0.01$. While the boy speeds up, which one of the following statements is **NOT** true:

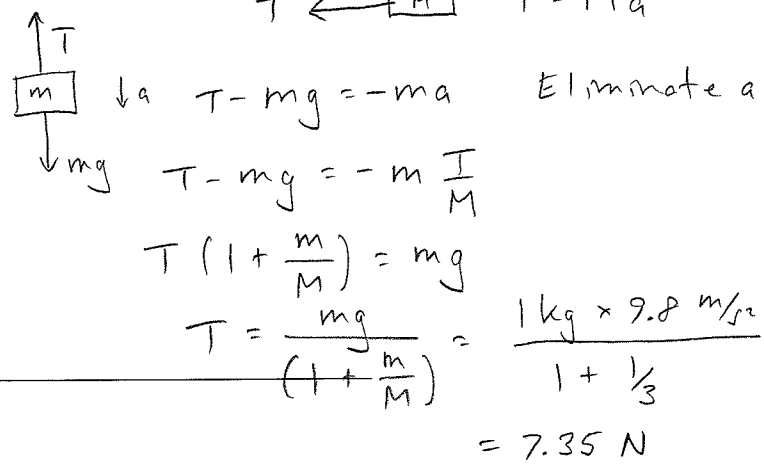
a. The gravitational force of the Earth on the sled and the gravitational force of the sled on the Earth are equal in magnitude.
(b.) The force of the boy pulling the sled and the frictional force by the ice on the sled are equal in magnitude.
c. The gravitational force of the Earth on the sled and the normal force of the ice on the sled are equal in magnitude.

18. The following question refers to the drawing below, which is similar to that used in the labs. The cart with mass M = 3 kg is pulled by a massless string and moving on a horizontal track. A weight with mass m = 1kg is hung from the other end of the string through a pulley system. Ignore all friction forces (g = 9.8 m/s^2). Due to the gravitational force acting on weight of mass m, the cart is accelerated to the left.



What is the tension (T) in the string?

a. T = 3.27 N
b. T = 4.9 N
(c.) T = 7.35 N
d. T = 9.8 N
e. T = 29.4 N



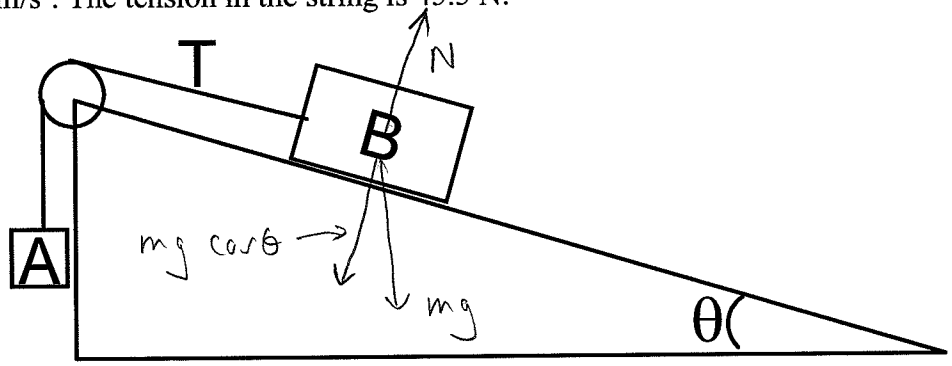
19. In another galaxy, a solar system similar to our own contains a planet that has the same mass as Earth, but it is made of a less dense rock, so its radius is 1.3 times the Earth's radius. How much would a 80 kg person weigh on the surface of that planet? The mass of Earth is 5.9742 x 10^{24}kg and the radius of Earth is 6.378 x 10^3 km.

a. 175 N
b. 464 N
c. 603 N
d. 784 N
e. 1019 N

NOT ON EXAM 1

The following 2 questions concern the same physical situation:

Block A is suspended vertically by an ideal string that passes over an ideal pulley and is then connected to Block B that is resting on a frictionless ramp with incline of $\theta = 25$ degrees as shown in the figure. Block B is observed to accelerate down the ramp at a rate of 2.2 m/s^2. The tension in the string is 45.5 N.



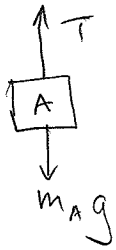
20. What is the magnitude of the normal force acting on Block B by the ramp?

a. $m_B g$
b. $m_B g * \sin\theta$
(c.) $m_B g * \cos\theta$

$N = mg \cos\theta$

21. Block B is now pushed hard against the ramp with a large normal force and held fixed, while Block A is still attached by the string. What is the tension, T, in the string?

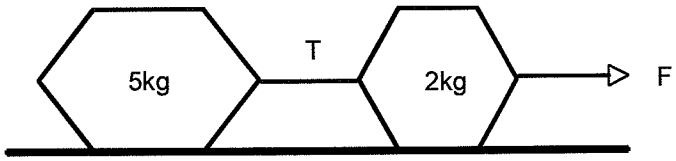
(a.) $m_A g$
b. $m_A g + m_B g$
c. $m_B g$
d. $m_A g + m_B g \sin(\theta)$
e. cannot determine



$T = m_A g$

The following 2 questions concern the same physical situation:

A 5 kg block is connected to a 2 kg block by a massless string. The force F pulls the 2 kg block to the right across a flat surface. The kinetic friction coefficient between the blocks and the surface is $\mu_k = 0.15$. The acceleration of the two blocks is measured to be 2.0 m/s^2.



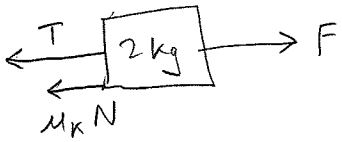
22. What is the magnitude of the net force on the 2 kg block?

(a.) 4.0 N
b. 14.6 N
c. 17.8 N
d. 7.1 N
e. 9.5 N

$F_{NET} = ma = 2\,kg \times 2\,m/s^2 = 4\,N$

23. What is the magnitude of the force F pulling the 2 kg block to the right?

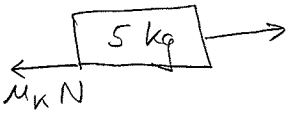
a. 17.8 N
(b.) 24.3 N
c. 68.6 N



$m = 2\,kg$

$F - T - \mu_K mg = ma$

$M = 5\,kg$



$T - \mu_K Mg = Ma$

Eliminate T:

$F - (Ma + \mu_K Mg) - \mu_K mg = ma$

Did you bubble in your name, exam version, and network ID?
Check to make sure you have bubbled in all your answers.

$F = (m+M)a + \mu_K(m+M)g$

$= (m+M)(a + \mu_K g)$

$= 7\,kg \times (2\,m/s^2 + 0.15 \times 9.8\,m/s^2)$

$= 24.29\,N$