Name (print, last first): $\qquad$ Signature: $\qquad$
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.
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(6) Hand in the answer sheet separately.

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

1. A ball is thrown up vertically at $20 \mathrm{~m} / \mathrm{s}$. How high will the ball go?
(1) 20.4 m
(2) 40.8 m
(3) 5.1 m
(4) 2 m
(5) 7.1 m
2. Jane sets out on a walk. She walks 5 km east and then 12 km north. How far is she from her starting point?
(1) 13 km
(2) 17 km
(3) 7 km
(4) 12 km
(5) 5 km
3. A stone is dropped from a bridge. It hits the water 3 seconds after it is dropped. What is the height of the bridge above the water?
(1) 44.1 m
(2) 22 m
(3) 10.5 m
(4) 66 m
(5) 5.5 m
4. A block of mass 10 kg sits on an inclined plane. The coefficient of static friction between the block and the surface is 0.75 . At what angle (in degrees) must the block be raised before it begins to slide?
(1) $37^{\circ}$
(2) $53^{\circ}$
(3) $89^{\circ}$
(4) $5^{\circ}$
(5) $45^{\circ}$
5. An automobile is initially backing up at a speed of $5 \mathrm{~m} / \mathrm{s}$. At time $t=0$ the automobile begins accelerating in the forward direction at $4 \mathrm{~m} / \mathrm{s}^{2}$. What is its net displacement after $4 s$ of acceleration? (In other words, if $X_{I}=0$, what is the value of $X_{F}$ at $t=4 s$ ?)
(1) 12 m
(2) 9 m
(3) 6 m
(4) 3 m
(5) 0 m
6. A police cruiser is traveling at $20 \mathrm{~m} / \mathrm{s}$. A car traveling in the same direction at $30 \mathrm{~m} / \mathrm{s}$ passes the cruiser. At this moment the car begins to accelerate in the forward direction at a rate of $2 \mathrm{~m} / \mathrm{s}^{2}$, and the cruiser begins to accelerate in the forward direction at $4 \mathrm{~m} / \mathrm{s}^{2}$. How far does the cruiser travel until it catches up to the car?
(1) 400 m
(2) 300 m
(3) 200 m
(4) 100 m
(5) 500 m
7. An astronaut wants to measure the acceleration of gravity on planet X. On Earth her powerful dart gun will shoot a dart a maximum horizontal distance of 30 m before the dart returns to the same height from which it was shot. She performs the same experiment on planet X , and finds that the dart gun shoots the dart a maximum distance of 45 m . What is the value of the acceleration due to gravity on Planet X?
(1) $6.5 \mathrm{~m} / \mathrm{s}^{2}$
(2) $3.8 \mathrm{~m} / \mathrm{s}^{2}$
(3) $9.8 \mathrm{~m} / \mathrm{s}^{2}$
(4) $12.4 \mathrm{~m} / \mathrm{s}^{2}$
(5) $15.9 \mathrm{~m} / \mathrm{s}^{2}$
8. A 0.02 kg bullet initially traveling at $500 \mathrm{~m} / \mathrm{s}$ imbeds itself in a 2 kg block. What is the kinetic energy of the block immediately after the collision?
(1) 24.5 J
(2) 19.8 J
(3) 15.6 J
(4) 33.4 J
(5) 8.3 J

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$$
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1. (4 points) A force P holds an object weighing 30 N a distance 3 m from the wall as shown as in the figure. The tie rope T is tied 4 m above the horizontal line of action P. Calculate P.
(1) 22.5 N
(2) 45 N
(3) 11.2 N
(4) 4.5 N
(5) 33.7 N

2. (3 points) A ramp inclined at 30 degrees to the horizontal is used to haul a load of 100 N up a height of 1 m . What is the ideal mechanical advantage of this elementary machine?
(1) 2.0
(2) 1.0
(3) 0.87
(4) 0.5
(5) 0.25
3. (3 points) The pulley system shown in the figure is used to lift an object that weighs 30 N . The rope is continuous around each pulley What is the tension T in the pulley rope?
(1) 10 N
(2) 30 N
(3) 15 N
(4) 60 N
(5) 3 N

4. (4 points) The boom shown in the figure has a length of 4 m . and weighs 300 N . It is used to lift a weight of 400 N . If the boom is inclined at 53 degrees to the horizontal, calculate the tension T in the tie which is linked to the boom at a distance of 3 m from the ground.
(1) 550 N
(2) 700 N
(3) 350 N
(4) 100 N
(5) 50 N

5. (4 points) Joe is standing in a canoe that has a mass of 40 kg . The canoe is at rest on the surface of a smooth lake. Joe jumps off the canoe with a speed of $5 \mathrm{~m} / \mathrm{s}$. If Joe has a mass of 80 kg , what is the velocity of recoil of the canoe after he jumps?

(1) $10 \mathrm{~m} / \mathrm{s}$
(2) $20 \mathrm{~m} / \mathrm{s}$
(3) 0
(4) $5 \mathrm{~m} / \mathrm{s}$
(5) $7 \mathrm{~m} / \mathrm{s}$
6. (4 points) A ping-pong ball of mass 2 gm and traveling with a velocity of $2 \mathrm{~m} / \mathrm{s}$ collides with stationary tennis ball of mass 10 gm . Calculate the velocity of the ping-pong ball after the collision, assuming the collision is elastic.
(1) $1.3 \mathrm{~m} / \mathrm{s}$
(2) $0.33 \mathrm{~m} / \mathrm{s}$
(3) $2 \mathrm{~m} / \mathrm{s}$
(4) $0.67 \mathrm{~m} / \mathrm{s}$
(5) $3.9 \mathrm{~m} / \mathrm{s}$
7. (4 points) The wheel of a car is rotating at a speed of $3.0 \mathrm{rev} / \mathrm{s}$. If the wheel has a diameter of 30 cm , how fast is the car going along its straight line path?
(1) $2.8 \mathrm{~m} / \mathrm{s}$
(2) $5.6 \mathrm{~m} / \mathrm{s}$
(3) $1.4 \mathrm{~m} / \mathrm{s}$
(4) $3.5 \mathrm{~m} / \mathrm{s}$
(5) $0.33 \mathrm{~m} / \mathrm{s}$
8. (4 points) A phonograph record rotates at 45 rpm (revolutions per minute). A fire ant sits on the record a distance of 5 cm from the center. How fast is the ant moving?
(1) $0.24 \mathrm{~m} / \mathrm{s}$
(2) $0.50 \mathrm{~m} / \mathrm{s}$
(3) $4.5 \mathrm{~m} / \mathrm{s}$
(4) $1.5 \mathrm{~m} / \mathrm{s}$
(5) $0.12 \mathrm{~m} / \mathrm{s}$

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$$
g=9.80 \mathrm{~m} / \mathrm{s}^{2} \quad R=8314 \mathrm{~J} / \mathrm{kmole} / \mathrm{K}
$$

1. (4 points) In the compression chamber of a diesel engine the volume of a gas mixture initially at $27^{\circ} \mathrm{C}$ is compressed by a factor of $20\left(V_{\text {Final }}=1 / 20 V_{\text {Initial }}\right)$. If the pressure increases from 1 atmosphere to 50 atmospheres, what is the final temperature?
(1) $477^{\circ} \mathrm{C}$
(2) $954^{\circ} \mathrm{C}$
(3) $273^{\circ} \mathrm{C}$
(4) $0^{\circ} \mathrm{C}$
(5) $1430^{\circ} \mathrm{C}$
2. (5 points) A misshapen lump of metal is weighed in air and then weighed while immersed in oil of density $800 \mathrm{~kg} / \mathrm{m}^{3}$. If the weight in air is 2.2 kg and the weight in the oil is 1.2 kg , calculate the density of the metal.
(1) $1760 \mathrm{~kg} / \mathrm{m}^{3}$
(2) $2650 \mathrm{~kg} / \mathrm{m}^{3}$
(3) $92 \mathrm{~kg} / \mathrm{m}^{3}$
(4) $36.8 \mathrm{~kg} / \mathrm{m}^{3}$
(5) $13.5 \mathrm{~kg} / \mathrm{m}^{3}$
3. (4 points) A 5 meter length of steel with a cross-sectional area of $20 \mathrm{~cm}^{2}$ is compressed with a force of $20,000 \mathrm{~N}$. If the Young's modulus of steel is $200 \times 10^{9} \mathrm{~N} / \mathrm{m}^{2}$, what is the change in length of the steel beam?
(1) 0.25 mm
(2) 2.5 cm
(3) 5.5 cm
(4) 0.11 cm
(5) 12.5 mm
4. (5 points) A cylinder of radius $b$ has a moment of inertia $I=(1 / 2) m b^{2}$. The cylinder is rolled along a flat horizontal surface at speed $v$ so that when it hits a ramp, it will travel to a height of 50 cm and then stop. What is the initial speed $v$ of the cylinder?
(1) $2.6 \mathrm{~m} / \mathrm{s}$
(2) $5.25 \mathrm{~m} / \mathrm{s}$
(3) $12.2 \mathrm{~m} / \mathrm{s}$
(4) $1.22 \mathrm{~m} / \mathrm{s}$
(5) $52.5 \mathrm{~m} / \mathrm{s}$
5. (4 points) An object has a moment of inertia of $2.56 \mathrm{~kg} \cdot \mathrm{~m}^{2}$. What is the value of the torque needed to accelerate the rotation of the object from rest to a rotation of 5 revolutions per second in 30 seconds?
(1) $2.68 \mathrm{~N} \cdot \mathrm{~m}$
(2) $1.34 \mathrm{~N} \cdot \mathrm{~m}$
(3) $0.27 \mathrm{~N} \cdot \mathrm{~m}$
(4) $4.02 \mathrm{~N} \cdot \mathrm{~m}$
(5) $0 \mathrm{~N} \cdot \mathrm{~m}$
6. (4 points) A $5 \mathrm{~m}^{3}$ tank of compressed helium gas has an absolute pressure of 4 kPa at a temperature of $27^{\circ} \mathrm{C}$. What is the mass of the helium in the tank? 1 kmole of helium weighs 4 kg .
(1) 33 g
(2) 13.5 g
(3) 1.61 kg
(4) 0.35 kg
(5) 6.42 kg
7. (4 points) A 100 meter length of steel changes temperature by $30^{\circ} \mathrm{C}$ during the course of a day. If the coefficient of thermal expansion of steel is 12 parts per million per ${ }^{\circ} \mathrm{C}$, what is the change in length of the steel?
(1) 3.6 cm
(2) 7.2 cm
(3) 14.4 mm
(4) 1.8 m
(5) 0.18 cm
