

Name _____ ID _____ Section _____

The exam is closed book and closed notes.

There are 10 multiple choice questions (1 pint each) and 2 Workout problems (2 and 3 points)
 Make sure you put your name, section, and ID number on the SCANTRON form. The answers for the multiple choice Questions are to be placed on the SCANTRON form provided. Use a Number 2 pencil to fill in answers on the SCANTRON form. Make sure you give only one (1) answer to each question. **If you erase an answer on the SCANTRON form, make sure all traces are removed.**

1. One mile is equal to 1609 m. The speed of 45 mph is equivalent to the speed of: → 2

- A) 20 m/s
- B) 1.61 m/s
- C) 36 m/s
- D) 29 m/s
- E) 161 m/s

$$(45 \text{ mi/hr}) \left(\frac{1 \text{ hr}}{3600 \text{ s}} \right) \left(\frac{1609 \text{ m}}{1 \text{ mi}} \right) =$$

2. One inch is equal to 0.0254 m. A box with the dimensions of 2.1 inch × 3 inch × 10 inch has a volume of: → 1

- A) 10⁶ m³
- B) 10³ m³
- C) 1 m³
- D) 10⁻³ m³
- E) 10⁻⁶ m³



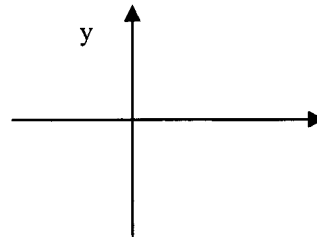
$$(2.1 \text{ in}) (0.0254 \text{ m/in}) (3 \text{ in}) (0.0254 \text{ m/in})$$

$$\rightarrow \times (10 \text{ in}) (0.0254 \text{ m/in})$$

$$1.03 \times 10^{-3}$$

3. The Figure below shows a two-dimensional system of coordinates with the x-axis pointing right and the y-axis pointing up. In the vector component notation, vectors $\vec{a} = 6\hat{i} - 4\hat{j}$ and $\vec{b} = 6\hat{i} + 4\hat{j}$. The difference of these vectors, $\vec{a} - \vec{b}$, points → 3

- A) no direction (the length of $\vec{a} - \vec{b}$ is zero)
- B) down
- C) up
- D) left
- E) at 45 degrees with respect to X



$$\vec{a} - \vec{b}$$

$$= (6-6)\hat{i} + (-4-4)\hat{j}$$

$$= -8\hat{j}$$

4. The angle between vectors $\vec{a} = 6\hat{i} - 4\hat{j}$ and $\vec{b} = 6\hat{i} + 4\hat{j}$ is equal to → 4

- A) 0°
- B) 33.5°
- C) 45°
- D) 67°
- E) 90°

$$\vec{a} \cdot \vec{b} = 36 - 16 = 20$$

$$\vec{a} \cdot \vec{b} = ab \cos \theta$$

$$\theta = \cos^{-1} \left(\frac{\vec{a} \cdot \vec{b}}{ab} \right) =$$

$$\theta = \cos^{-1} \left(\frac{20}{7.2 \times 7.2} \right) = 67^\circ$$

$$|\vec{a}| = \sqrt{6^2 + 16^2} = 7.2$$

$$|\vec{b}| = 7.2$$

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5. A 2 kg ball is initially at rest and is dropped from a height of 8 m above a table. What is the velocity of the ball just before impact with the table?

- A) 8 m/s
- B) 2 m/s
- C) 20 m/s
- D) 98 m/s
- E) 12.5 m/s

$$v^2 - v_0^2 = 2a(y - y_0)$$

$$v_0 = 0$$

$$v = \sqrt{2a(y - y_0)} = \sqrt{2(9.8)(8)} = 12.5 \text{ m/s}$$

→ 6

6. A particle moves along a straight line with an acceleration of 10 m/s² to the left but an initial velocity of 20 m/s to the right. What is the TOTAL LENGTH of the PATH traveled both left and right by the particle in the first 5 seconds?

- A) 65 m.
- B) 20 m.
- C) 45 m.
- D) 25 m.
- E) 200 m

$$V(t) = v_0 + at$$

$$0 = v_0 + at$$

$$t_1 = \frac{v_0}{a} = \frac{20}{10} = 2 \text{ s}$$

$$0 \rightarrow 2 \text{ sec: } x_1 = v_0 t + \frac{1}{2} a t^2 = 20(2) - \frac{1}{2}(10)(2)^2 = 20$$

$$2 \rightarrow 5 \text{ sec } x_2 = v_0 t + \frac{1}{2} a t^2 = \frac{1}{2}(-10)(3)^2 = 45$$

65 m

→ 5

7. Identical guns fire identical bullets A and B horizontally from different heights (h_A=10 m and h_B=20m) above the level plane of the ground. The initial speed of the bullet A is the same as that for the bullet B. The air friction can be neglected. Which of the following statements is/are true?

- I. The horizontal distance traveled by the bullet A is the same as that for the bullet B.
- II. The flight time for the bullet A is 2 times longer than that for the bullet B.
- III. The flight time for the bullet A is less than that for the bullet B.
- IV. The horizontal component of velocity of the bullets at impact with the ground are the same.

- A) I and III
- B) I and IV
- C) II only
- D) I, II, and IV
- E) III, and IV

→ 8

8. A football is thrown toward a receiver with an initial speed of 15 m/s at an angle of 45° above the horizontal. At what horizontal distance the receiver should be to catch the football at the level at which it was thrown?

- A) 16 m;
- B) 23 m
- C) 31 m
- D) 45 m
- E) Impossible to solve; need the mass of the football

$$v_y = 15 \sin 45 = 10.6 \text{ m/s}$$

$$y = y_0 + v_0 t + \frac{1}{2} a t^2$$

$$v = v_0 + g t^2$$

$$0 = t(v_0 - g t) \quad t = \frac{v_0}{g} = \frac{10.6}{9.8} = 2.1$$

→ 7

9. A car slows from the velocity of v₀ = +26 m/s to zero in 18 s with a constant acceleration. What are the car's displacement Δx and acceleration a ?

- (a) $\Delta x = 234 \text{ km}, a = -0.72 \text{ m/s}^2$
- (b) $\Delta x = 234 \text{ m}, a = 1.44 \text{ m/s}^2$
- (c) $\Delta x = 468 \text{ m}, a = 1.44 \text{ m/s}^2$
- (d) $\Delta x = 468 \text{ m}, a = -1.44 \text{ m/s}^2$
- (e) none of the above

$$v = v_0 + at$$

$$0 = v_0 + at$$

$$a = -\frac{v_0}{t} = -\frac{26}{18} = -1.44$$

$$\Delta x = \frac{v^2 - v_0^2}{2a} = \frac{-(26)^2}{2(-1.44)} = 235 \text{ m}$$

$$x = 2.1 * v_x = 2.1 * 10.6 = 22 \text{ m}$$

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10. How many miles a pulse of light will travel in one hour?

Use 3×10^8 m/s for the speed of light and the following conversion: 1 mile = 1.609 km.

- (a) 6.7×10^8 miles
- (b) 10.8×10^8 miles
- (c) 10.8×10^{11} miles
- (d) 6.7×10^{11} miles
- (e) 1.74×10^9 miles

$$(3 \times 10^8 \text{ m/s}) \left(\frac{1 \text{ km}}{10^3 \text{ m}} \right) * \left(\frac{1 \text{ mi}}{1.609 \text{ km}} \right) \left(\frac{3600 \text{ s}}{1 \text{ h}} \right) (1 \text{ h})$$
$$= 6.7 \times 10^8 \text{ mi}$$

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Workout Problems

Write full solution to the Workout problems. Answers without complete calculations (step by step) will not be credited. Clearly write the answers with dimensions in the space provided below. Grades will be reduced if the work is hard to read. Use the back side of the page if needed.

Workout problem I. (2 points)

A toy rocket, launched from the ground with zero initial velocity, rises vertically with an acceleration of $a = +20 \text{ m/s}^2$ for 6.0 seconds until its motor stops. After that it is moving under the influence of the gravity ($a = -9.8 \text{ m/s}^2$). Disregard any air resistance.

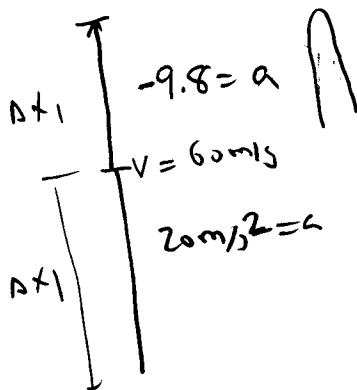
- a) What is the velocity of the rocket when its motor stops?

Ans: Velocity _____ [].

$$v = v_0 + at = (20 \text{ m/s}^2)(6.0) = 120 \text{ m/s}$$

- b) Assuming that the rocket keeps moving along the same straight vertical line, what maximum height above the ground will the rocket achieve?

Ans: Maximum height _____ [].



$$v^2 - v_0^2 = 2a \Delta x$$

$$\Delta x_1 = \frac{v^2}{2a} = \frac{(120 \text{ m/s})^2}{2(20)} = 360 \text{ m}$$

$$\Delta x_2 = \frac{v^2 - v_0^2}{2a} = \frac{-v_0^2}{2a}$$

$$= \frac{-(120 \text{ m/s})^2}{2(-9.8)} = 735 \text{ m}$$

$$\Delta x_1 + \Delta x_2 = 360 + 735$$

$$= 1095 \text{ m}$$

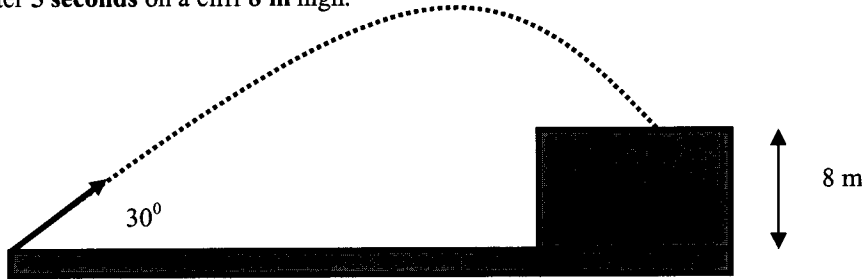
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Workout problem II. (3 points)

A stone is projected from the ground level with an initial speed V_0 directed 30° above the horizontal. It lands after 5 seconds on a cliff 8 m high.



c) What is the magnitude of the initial velocity of the stone?

Ans: 52 m/s [] m/s

$$V_{0y} = V_0 \sin \theta = 26.1 \text{ m/s}$$

$$V_0 = \frac{26.1}{\sin(30)} = 52.2 \text{ m/s}$$

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

$$y = t(v_{0y} + \frac{1}{2}at)$$

$$8 = tV_{0y} + \frac{1}{2}at^2$$

$$V_{0y} = \frac{8 + \frac{1}{2}gt^2}{t} = \frac{8 + \frac{1}{2}9.8(5)^2}{5} = 26.1 \text{ m/s}$$

d) What is the horizontal and vertical components of its velocity and velocity magnitude just before the stone hits the cliff?

Ans: Velocity magnitude:

Horizontal component of velocity

Vertical component of velocity

52 [] m/s

45 [] m/s

-23 [] m/s

$$V_x = 52 \cos(30) = 45 \text{ m/s}$$

$$V_y = V_0 \sin 30 - gt = 52 \sin(30) - 9.8(5) = -23 \text{ m/s}$$

$$V = \sqrt{(45)^2 + (23)^2} = 50 \text{ m/s}$$

e) How far from the release point does the stone hit the cliff?

Ans: Distance: 225 m/s [].

$$V_{0x} = 45 \text{ m/s}$$

$$x = v_{0x}t = 45 * 5 = 225 \text{ m/s}$$