TA's have new office hours.
Please see online syllabus
Lots of Thursday help

New groups for Thursday

Read 4.1 - 4.6

Exam

80 - 100 A
60 - 80 B
40 - 60 C
< 40 D-F

Remember 40% H.W, clicker, qiz
40% midterm

Chapter 4

chapters 2-3 How objects move

chapter 4 why objects move

Force:

How objects interact

Push

Pull

Push or Pull → DIRECTION

VECTOR

Force is always the interaction between 2 objects

Need to identify what causes force and what object force acts on

you and your friend want to move a piano

You both push (apply a force)

Result depends on what <u>direction</u> and how hard you push (magnitude)

Force → Vector

Piano starts from rest
(velocity = 0 m/s)

After applying (Net) Force, piano moves
(velocity > 0)

$\Rightarrow$ acceleration ($\vec{a}$)

relationship between Force and acceleration

vector
Forces
acceleration

scalar
time

MANY "Different" types of FORCES

- GRAVITY
- FRICTION
- Buoyant
- SPRING
- NORMAL
- TENSION

NEWTON'S LAWS OF MOTION

I If NO NET FORCES ACT ON AN OBJECT, THEN ITS SPEED and DIRECTION DO NOT CHANGE

SPEED & DIRECTION → VELOCITY

II $\vec{F}_{net} = m\vec{a}$

NET FORCE = mass · acceleration

$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$ $\vec{a} = 0 \leftrightarrow$ CONST VELOCITY

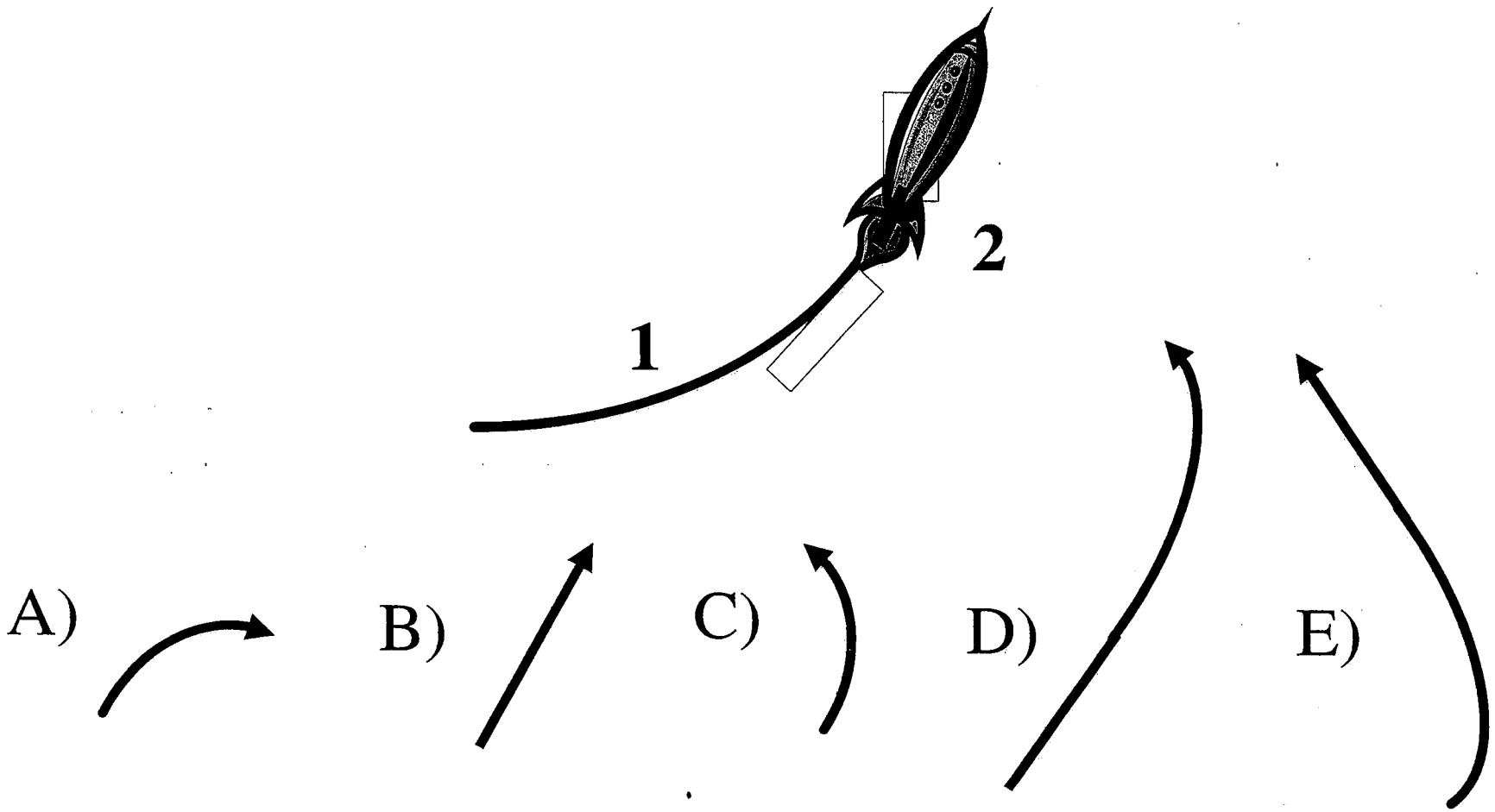
$\frac{\text{CHANGE IN VELOCITY}}{\text{CHANGE in TIME}}$

III IF TWO BODIES INTERACT, THE FORCE ON EACH OTHER ARE

- EQUAL IN MAGNITUDE
- OPPOSITE IN DIRECTION

Interactive Question

A rocket ship in space has its engines firing and is following path **1**. At point **2**, the engines shut off. Which path does the rocket ship follow?



A moving object with an applied net force suddenly has the net force removed. Which statement below about this object is true?

A) The object comes to an abrupt stop.

B) It slows down and then comes to rest.

C) It continues moving at constant velocity.

D) It speeds up.

E) I don't know.

(C)

You are an astronaut in space. You fire your jetpack to move around outside your spaceship. When you turn off your jetpack…

A) You come to rest quickly.

B) You slow down and come to rest.

C) You drift at constant speed in a straight line.

D) You drift at constant speed in different directions.

E) You don't know.

An object is moving at constant velocity. Which statement below about this object is true?

A) It experiences a net force in the direction of motion.

B) It is experiences a net force opposite to the direction of motion.

C) It experiences no net force.

D) It experiences no forces.

E) I don't know.

2nd Law

$$\Sigma \vec{F} = m\vec{a}$$

$\Sigma \vec{F}$: net Force acting on object of mass m

SI unit of Force

$ma = kg \cdot m/s^2$ Newton (N)

British unit of force: pound (lb)

Newton's 1st law is a special case when $\vec{a} = 0$

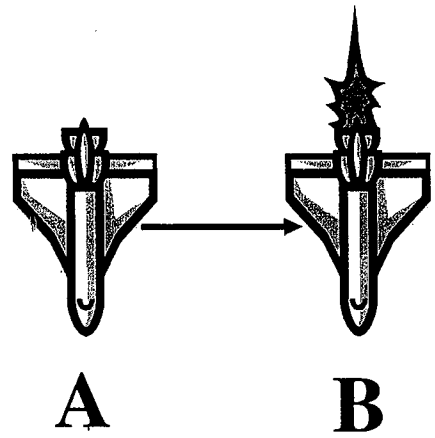
Interactive Question

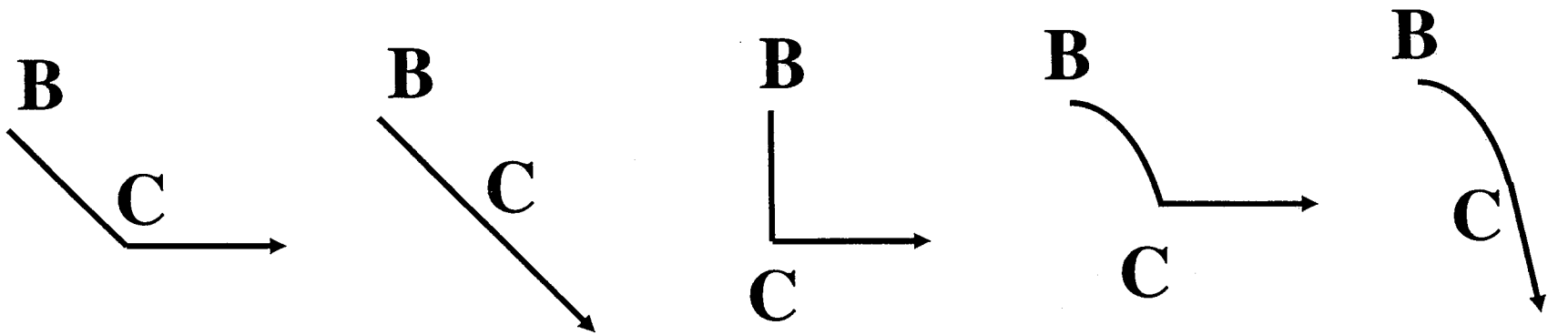
A constant force is exerted for a short time interval on a cart that is initially at rest on an air track with no friction. This force gives the cart a certain final speed. We repeat the experiment but, instead of starting from rest, the cart is already moving with constant speed in the direction of the force at the moment we apply the force. After we exert the same constant force for the same short time interval, the increase in the cart's speed

A) is equal to two times its initial speed.
B) is equal to the square of its initial speed.
C) is equal to four times its initial speed.
D) is the same as when it started from rest.
E) cannot be determined from this information.

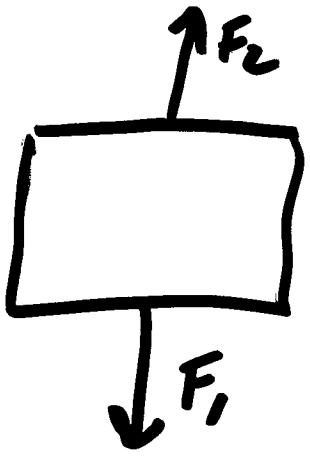
Interactive Question

A rocket is moving sideways in deep space from point **A** to **B**, with its engine off. Its engine is fired at point **B** and left on for 2 seconds while the rocket travels from point **B** to some point **C**? What path does the rocket travel from **B** to **C**, then from point **C**, after the engine is turned off?





(A) (B) (C) (D) (E)

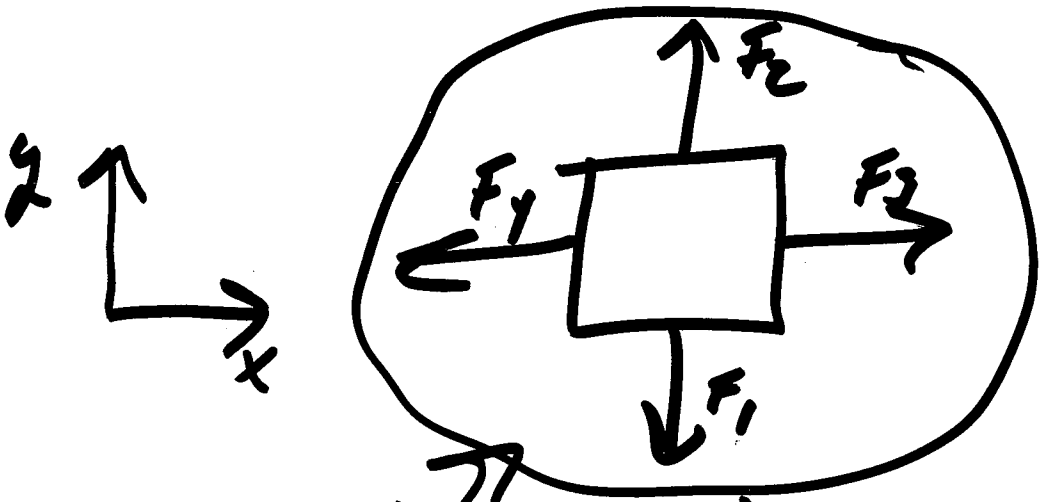


$\Sigma F = ma$

$\vec{F}_1 + \vec{F}_2 = 0$

$\vec{a} = 0$

$\vec{v}$ = constant



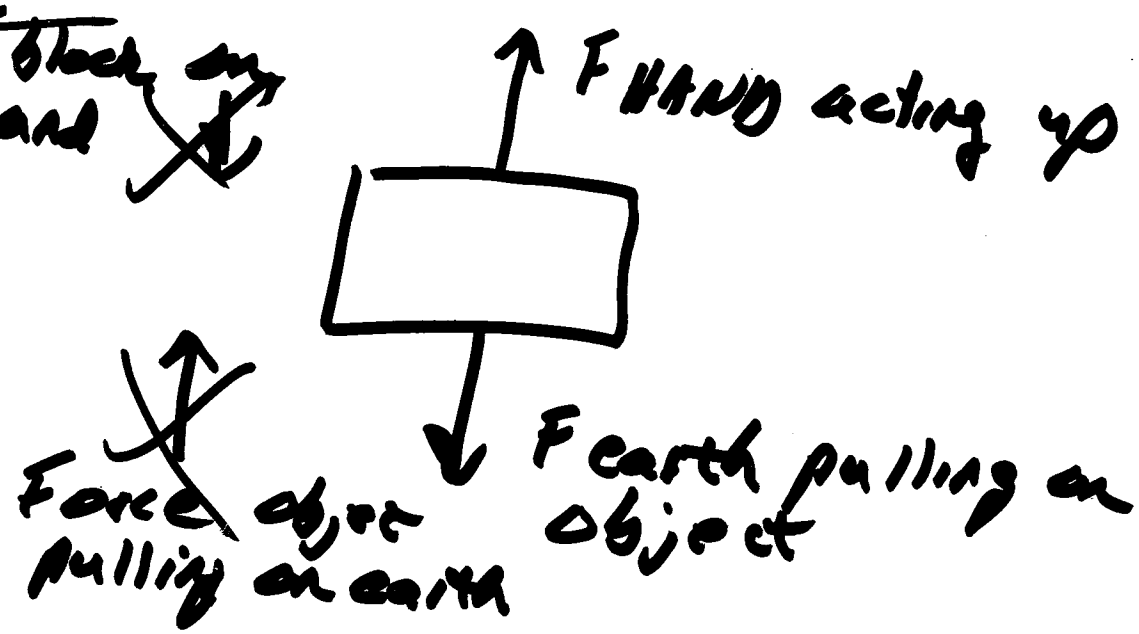
$\vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4 = m\vec{a} = 0$

FREE Body DIAGRAM

FREE BODY DIAGRAMS

SHOW <u>ALL</u> OF THE FORCES ACTING ON A BODY

THESE ARE THE FORCES USED WHEN APPLYING NEWTON'S 2nd LAW



FORCES ACTING BETWEEN BODIES WHICH ARE RELATED BY NEWTON'S <u>3rd LAW</u>
(FORCES BETWEEN 2 OBJECTS)
NEVER OCCUR ON SAME F.B.D.