USING CONCEPTUAL MULTIPLE CHOICE QUESTIONS

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OUTLINE

(1) What do I mean by
"conceptual" MC?

(2) Using MC questions in class

(3) Using MC questions on exams

(4) My collection of MC questions

Conceptual MC

- no calculators necessary

- typically use words or pictures (instead of numerical data) to describe a physical system

A chunk of ice at −20°C is added to a thermally insulated container with very cold water at 0°C. What happens next?

(A) The ice melts until thermal equilibrium is established.

(B) The water cools down until thermal equilibrium is established.

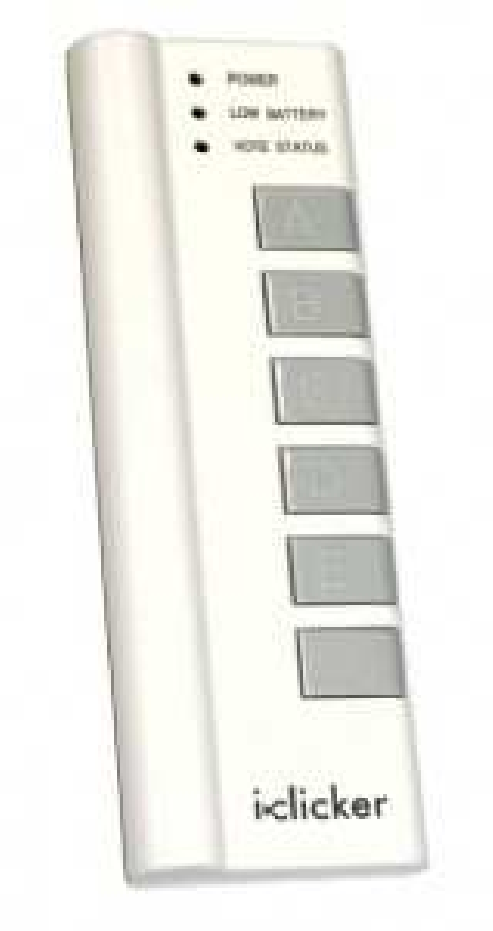
(C) Some of the water freezes and the chunk of ice gets larger.

(D) Nothing happens.

Q7: Stickman Stu is standing in front of a mirror, as shown in the figure below.

Based on the appearance of his reflection, what kind of mirror is it?
(A) concave
(B) convex
(C) planar
(D) no mirror could produce this effect

MC in class



- look for compelling questions which are neither too easy nor too hard

- repeat for discussion or for retention

Suppose you drive to Edmonton (100 km away) at 200 km/h & return at 100 km/h. What is your average velocity for the entire trip?

(A) zero

(B) 150 km/h

(C) less than 150 km/h

(D) more than 150 km/h

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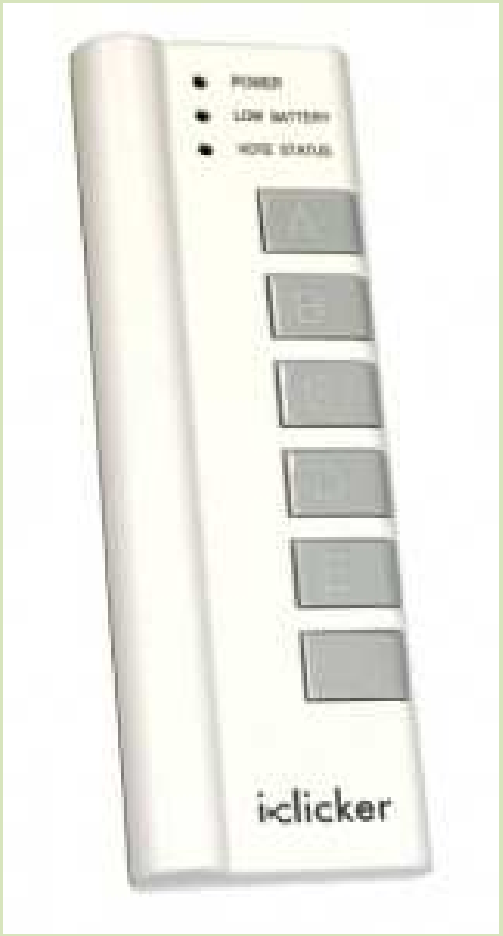
MC in class



- can use this to connect to a numerical problem (in seminars especially)
- can use this to predict the outcome of a demonstration

MC on exams

(1) Faster for students, allowing for a wider (and thus more accurate) survey of student knowledge than with numerical problems alone.

MC on exams

(2) Allows for coverage of qualitative topics that do not lend themselves to numerical problems.

MC on exams

(3) Addresses a wider range of learning styles and encourages broader student learning when preparing for exams.

MC on exams

(4) Helps to mitigate the common bimodal grade distributions encountered on physics exams.

MC on exams

(5) Faster marking, leading to faster turnarounds.

My exam format:

50 minute in-class midterm:

(I) 7 MC (35%)

(II) 1 Written Response (15%)

(III) 2 Numerical Problems (25% each)

My exam format:

3 hour final exam:

(I) 14 MC (28%)

(II) 2 Written Response (12%)

(III) 6 Numerical Problems (10% each)

Lots of MC…

Midterms: 14

Final exam: 14

Previous/sample exams: 28

Clickers: ~40

TOTAL: ~100

My MC collection

With acknowledgements to:

- Paul Hewitt (“Figuring Physics” & arborsci.com)
- Monash University (“Questions without numbers”)
- Ohio State University
- Force Concept Inventory
- Eric Mazur (“Peer Instruction”)
- Randy Knight (various books)
- Adam Sarty
- Various CAP talks over the past decade

My MC collection

Based on four major courses:

- Mechanics (232)
- Waves, Thermodynamics, and Optics (173)
- Electricity & Magnetism (113)
- Modern Physics (126)

Mechanics

(1) Introduction

(2) Kinematics

(3) Dynamics

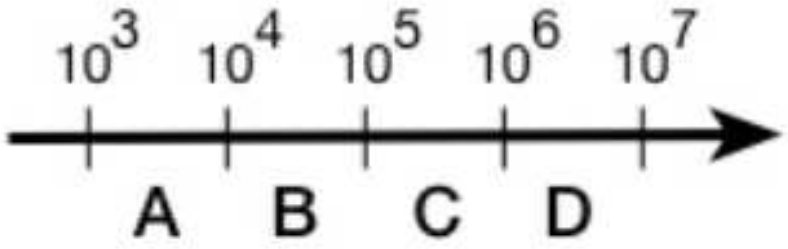
(4) Energy & Momentum

(5) Rotational Motion

Introduction samples

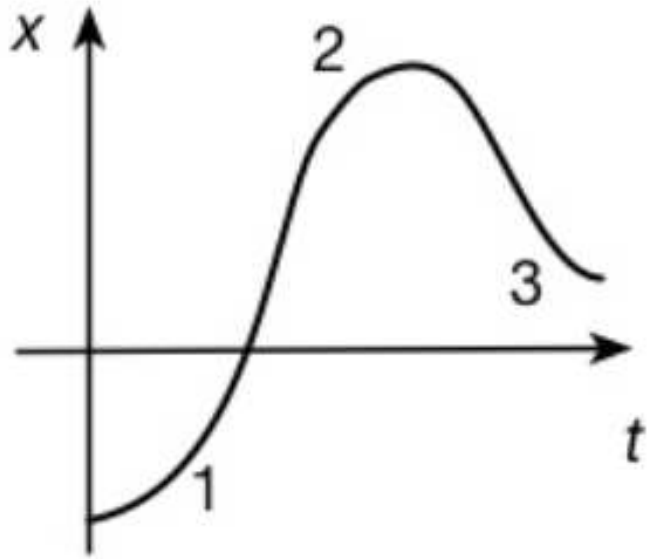
Q2: The "Hubble constant" is used in a formula which describes the observation that our universe is expanding in all directions. Its value is Ho = 69.3 (km/s)/Mpc, where Mpc refers to the megaparsec, an extremely large unit of distance. What sort of quantity does the Hubble constant represent?
(A) a distance
(B) a speed
(C) an acceleration
(D) the reciprocal of a time

Q16: Which of the following is the best estimate for the number of sheets of paper that would be needed to create a stack as tall as you?



Kinematics sample

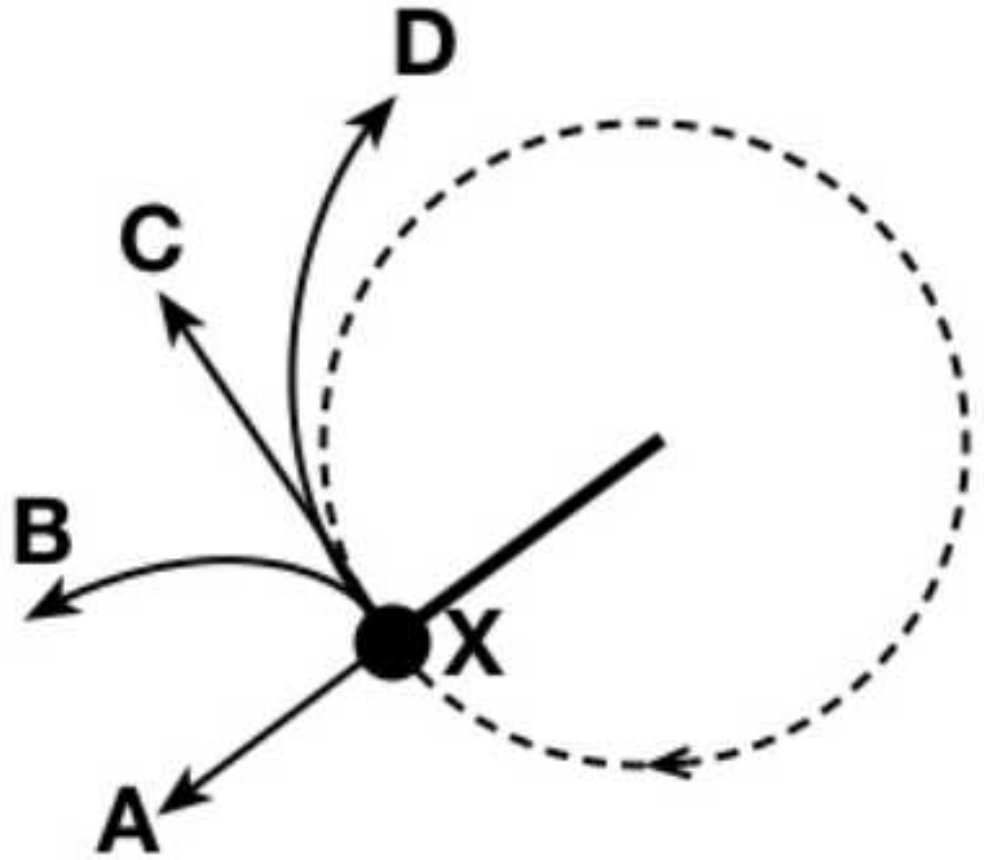
Q18: The figure below shows the position of a robot, moving back and forth in one direction, as a function of time.



At which instant does the robot have a negative acceleration?
(A) instant 1
(B) instant 2
(C) instant 3
(D) the acceleration is never negative

Dynamics sample

Q29: A heavy rock is tied to one end of a thin piece of string and is swung in a horizontal circular path, as seen from overhead in the picture below. If the string suddenly snaps at point X, along which of the paths would the rock travel?



Energy & Momentum samples

Q14: A bungee jumper has an elastic cord attached to her feet. The cord, whose unstretched length is nine meters, behaves just like a spring and is attached at the other end to the top of a platform high above the ground. After the bungee jumper steps off the platform, when is her speed the greatest?
(A) nine meters below the platform, when the cord first begins to stretch
(B) when the upward force from the cord balances the downward force of gravity
(C) at the lowest point, when the gravitational potential energy is smallest
(D) when the kinetic energy equals the elastic potential energy in the cord

Q21: Electricity is sold by the "kilowatt hour" (kWh). What does this measure?
(A) power
(B) electrical current
(C) energy
(D) time

Rotational Motion samples

Q15: A solid sphere and a hollow sphere begin to roll up a long ramp with the same initial speed. Which sphere will travel furthest up the ramp before stopping?
(A) the solid sphere
(B) the hollow sphere
(C) they both will travel the same distance up the ramp
(D) it depends on the relative masses and sizes of the spheres

Q22: An old star can begin to contract if its rate of nuclear energy production diminishes. If such a star is rotating, the contraction will cause
(A) both the angular momentum and the rotational kinetic energy to increase
(B) both the angular momentum and the rotational kinetic energy to remain constant
(C) the angular momentum to increase and the rotational kinetic energy to remain constant
(D) the angular momentum to remain constant and the rotational kinetic energy to increase

W, T, & O

(1) Waves

(2) Thermodynamics

(3) Optics

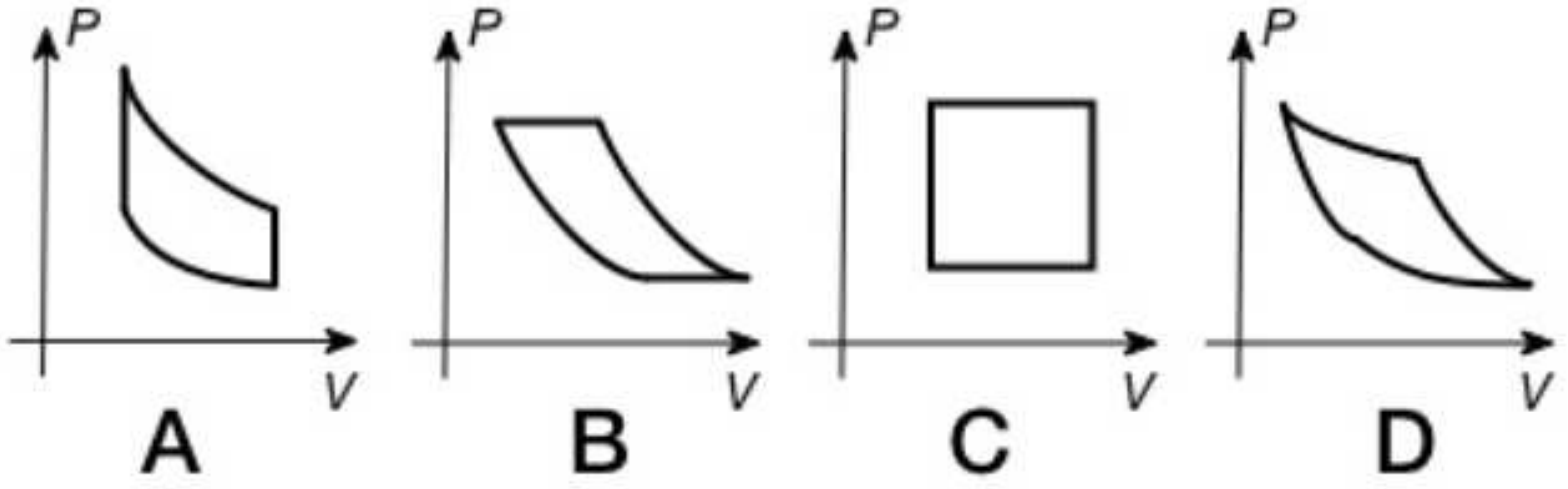
Waves samples

Q1: If A is the amplitude of a vibrating mass on a spring then in one period the mass travels a distance of
(A) 0
(B) A
(C) 2A
(D) 4A

Q40: A sound wave is generated by the howl of a wolf in the night. How would we describe the motion of a particular air molecule near the ground, a mile away from the wolf, on average (i.e., ignoring the random wandering of gas molecules)?
(A) It moves up and down in an oscillatory fashion
(B) It moves away from the wolf at the speed of sound
(C) It moves back and forth towards the wolf
(D) It moves in a horizontal circle

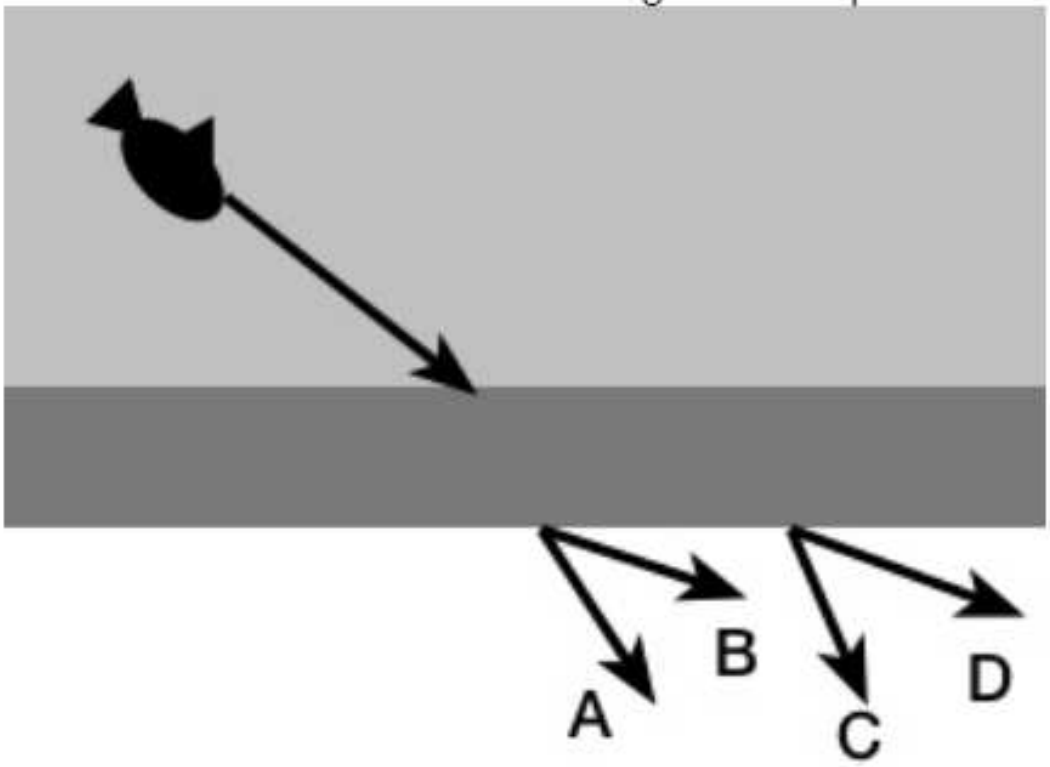
Thermodynamics sample

Q42: The Stirling Cycle is a sequence of four thermodynamic processes which can be used to design a heat engine:
(1) Expose a fixed volume of gas to an external heat source.
(2) Isothermally expand the gas by heating it further.
(3) Remove some heat from the gas without changing its volume.
(4) Isothermally compress the gas back to its original volume.
Which of the PV-diagrams below best depicts this cycle?



Optics sample

Q15: A mutant goldfish shoots a beam of green laser light towards the glass on the side of an aquarium tank, as seen from above in the figure below. If the index of refraction of the glass is greater than that of the water, which of the arrows best indicates the location and direction of the laser light after it passes through the glass?

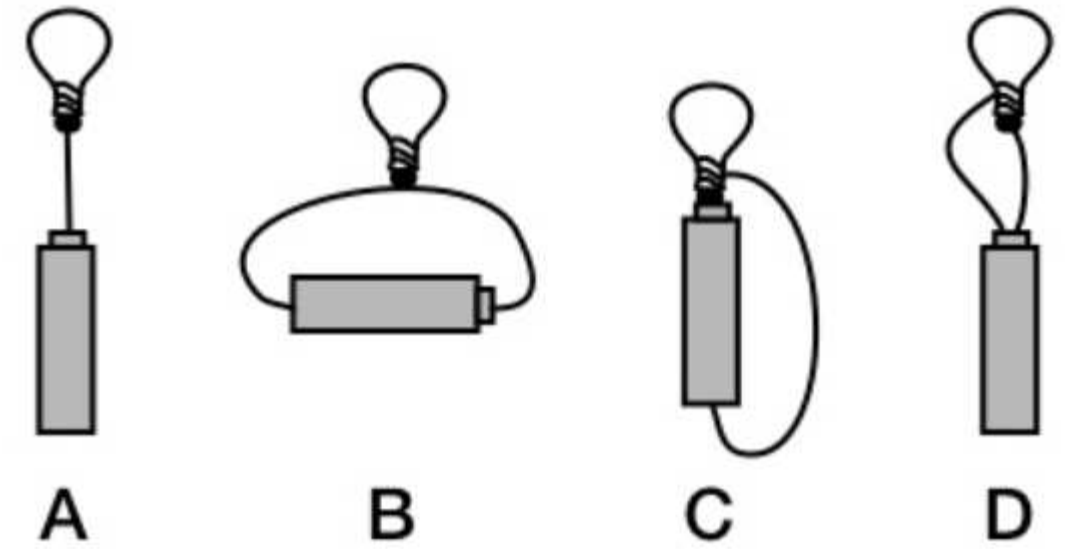


E & M

(1) Electricity & Magnetism

E & M samples

Q51: In an incandescent light bulb, one end of the filament connects to the rounded metal region on the base of the bulb while the other end of the filament connects to the threaded metal region around the sides of the bulb near the base. We wish to light up a small incandescent light bulb using a battery and a single piece of wire. Which of the arrangements below will accomplish this?



Q79: Which of the following scenarios, if any, is possible for an electron?
(A) Moving at constant velocity in a uniform electric field
(B) Slowing down in a uniform magnetic field
(C) Remaining stationary in a location where there are nonzero electric and magnetic fields
(D) None of the above scenarios are possible

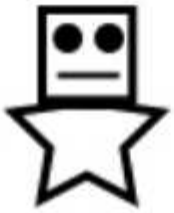
Modern Physics

(1) Relativity

(2) Pre-Quantum

(3) Quantum

Relativity samples

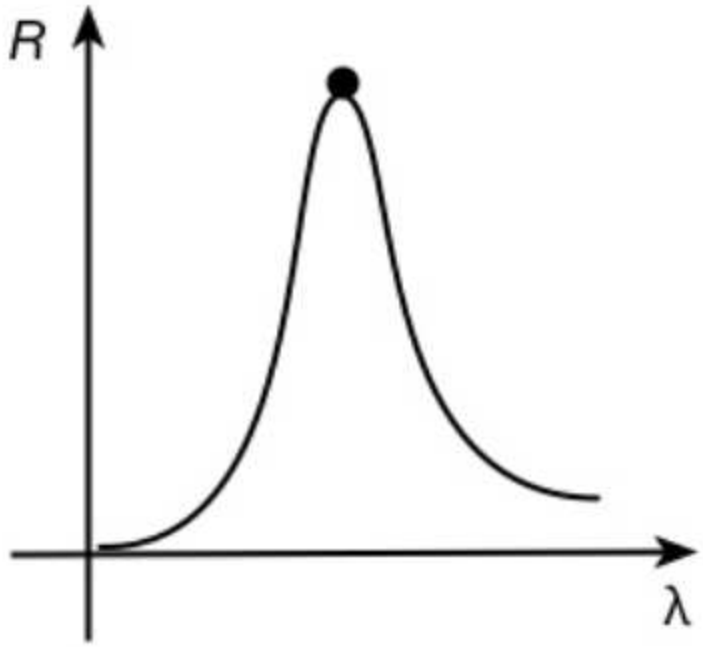
Q11: A square-headed alien  plummets feet-first to Earth at a ridiculously high speed. Due to length contraction, an observer inside a skyscraper would see this alien to be

Q28: An unstable particle, initially at rest, decays into a neutron and a photon. Which of these decay products has the greater energy?

(A) the neutron
(B) the photon
(C) they will have the same energy
(D) it depends on their relative directions

Pre-quantum sample

Q6: An object has a radiation spectrum as shown below.



In which direction will the dot at the peak of the spectrum move if the object's temperature is increased?

(A) ↗

(B) ↘

(C) ↙

(D) ↖

Quantum samples

Q21: A mass is attached to one end of a spring and is oscillating back and forth horizontally. Although classical physics describes this macroscopic system quite well, the correspondence principle promises us that a limiting case of a quantum physics interpretation will lead to the same result. So: if we had a wavefunction for the mass, where would it obtain its largest values?

(A) near the endpoints
(B) near the center of its motion
(C) everywhere — the wavefunction would be constant
(D) none of the above

Q30: A 5*p* electron emits a photon. Where can the electron end up?

(A) 5*s*
(B) 4*p*
(C) 2*d*
(D) none of the above

My MC collection

Question formats:

(1) Plain text + JPG files

(2) PDF documents

(no answers)

My MC collection

Terms of Sharing:

(1) Instruction or Research

(2) All initial requests to me

(3) Modifications & limited access for your students OK

My MC collection

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