Name: _____

Stages of Discovery: Revolutions in Art and Science
Fall Physics Exam – Revision Version

1) You are provided with a lens similar to one you worked with in physics workshop, with known focal length of 4 cm.

a) You place an object 12 cm from the lens. How far away from the lens (on the other side from the object) would you need to place a screen in order to obtain a clearly focused image?

b) You move the object so that is 24 cm from the lens. How far away from the lens (on the other side from the object) would you need to place a screen in order to obtain a clearly focused image? Is this closer to the lens, further from the lens, or the same distance from the lens as you obtained in part a)?

c) You move the object so that it is 2 cm from the lens. Show that there is no location you can put the screen where an image will form.

3) Galileo made several claims about factors which could affect the period of a pendulum. Which of the following factors did **Galileo conclude** did **NOT** affect the period of a pendulum?

Mass of the bob   **Angle of swing**   **Length of pendulum**

5) The period of a 100 cm long pendulum swinging through small angles is 2 seconds. Determine the length of a pendulum that has a period of 3 seconds.

6) Consider the four position vs. time graphs Graph A, Graph B, Graph C, and Graph D (shown on the original exam)

a) Briefly explain why Graph A and Graph C could represent an object moving with constant speed.

b) Briefly explain why Graph B could represent an object moving with uniformly accelerated motion, and why Graph D could **_not_**.

c) Which graphs could represent the horizontal part of projectile motion?   **A   B   C   D**

d) Which graphs could represent the vertical part of projectile motion?   **A   B   C   D**

7) Two metal balls are the same size and shape, but one weighs twice as much as the other. The balls are dropped from the roof of a single story building at the same time. Neglect air resistance.

a) Which ball hits the flat ground first?

The heavier ball	**The lighter ball**	**They hit the ground at the same time**	**Not enough information**

b) The two metal balls of the previous problem roll off a horizontal table with the same speed. Which ball hits the flat ground the farther horizontal distance from the base of the table?

The heavier ball	**The lighter ball**	**They hit the ground the same horizontal distance away from the table**	**Not enough information**

8) Two identical metal balls are loaded into a device like one used in class. Ball A is released from rest and falls straight down. Ball B is launched so it has initial horizontal velocity but no initial vertical velocity. Ball A is released at the same time that Ball B is launched, both from the same height above the table. Neglect air resistance.

a) Which ball hits the flat table the farther horizontal distance away from its release/launch point?

Ball A	**Ball B**	**They hit the table the same horizontal distance from their release/launch points**	**Not enough information**

b) Consider the same scenario as the previous problem, with Ball A released at the same time that Ball B is launched, both from the same height above the table. Which ball hits the table first?

Ball A	**Ball B**	**They hit the table at the same time**	**Not enough information**

9) It takes light approximately 8 minutes to travel from the Sun to the Earth.

a) Write down the distance between the Sun and the Earth in light-minutes:

b) Determine the distance between the Sun and the Earth in meters. Note there are 60 seconds in 1 minute.

10) You're on a train moving at constant velocity of $0.5c$ **to the right** with respect to the ground. You shine a pulse of light **to the left**. The speed of light is $1.0c$ in your reference frame. What does a ground-based observer measure as the speed of the light pulse?

$0.5c$	$1.0c$	$1.5c$	$0.5c$	$1.0c$	$1.5c$
(to the left)	**(to the left)**	**(to the left)**	**(to the right)**	**(to the right)**	**(to the right)**

11) Eva Green is chasing her pet duck, Gooey. Eva is moving to the right at a constant speed of $0.6c$ with respect to the ground. Gooey is also moving to the right at constant speed of $0.8c$ with respect to the ground. Determine Gooey's speed with respect to Eva.

12) NASA sends out an interstellar mission to a nearby Star, which is 12 light years away as measured by observers on the Earth. The crew travels at a constant speed of $0.6c$, relative to the Earth and the Star. Assume Earth and Star are at rest with respect to each other. Determine Δt_{crew} (the duration of the trip measured by the crew).

13) Brecht and Einstein leave Germany, one behind the other, at constant speed $0.8c$ with respect to the ground. As they pass Schoenberg who is standing at the border, Schoenberg notes that 0.012 seconds passed on his watch between Einstein leaving Germany and Brecht leaving Germany. How much time passed between Einstein and Brecht each passing Schoenberg, according to Brecht and Einstein?

14) Events A, B, and C are shown on the spacetime diagram to the right.

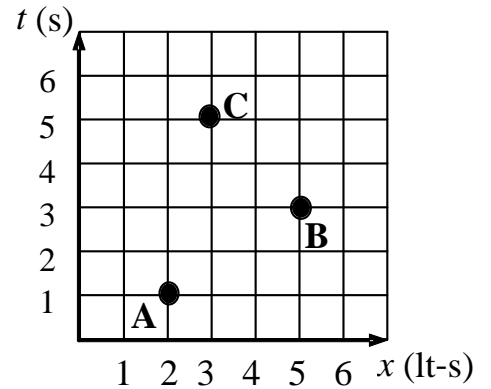a) Which pair(s) of events are separated by a time-like interval?

AB   **AC**   **BC**   **None**

b) Which pair(s) of events are separated by a light-like interval?

AB   **AC**   **BC**   **None**

c) Which pair(s) of events could be causally linked?

**AB**   **AC**   **BC**   **None**

15) The spacetime diagram shows the worldlines of Earth and a Rocket, as well as several labeled events.

a) How fast is the Rocket moving, relative to the Earth?

0 $\frac{3}{5}c$ $\frac{4}{5}c$ c $\frac{5}{4}c$ $\frac{5}{3}c$

b, c) Order these events in time, from earliest to latest, according to the Earth's reference frame:

d, e) Order these events in time, from earliest to latest, according to the Rocket's reference frame:
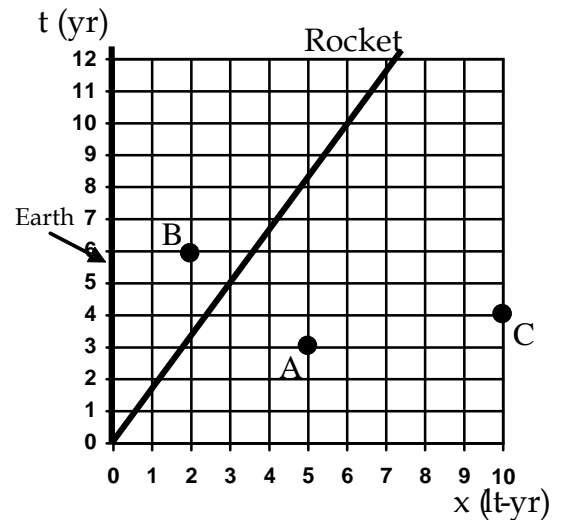
f) Event B is the emission of a light pulse towards the Rocket. Carefully draw and label the worldline of the light pulse on the diagram.

16) Andrea is at rest with respect to the ground. Andrea snaps her fingers, and 4 seconds later, she snaps them again. Elizabeth, riding (very fast) on her bike past these events at constant speed, notes that, as measured in her frame, the time between finger snaps was 5 seconds.

a) In Elizabeth's frame, what is the distance between the two snaps occur?

b) How fast is Elizabeth going with respect to Andrea (and the ground)?