LAST NAME **as on student card**	First Name(s) **as on student card**	Student Number	Practical Group Code

PHY131H1F
Term Test —version B
Tuesday, September 30, 2014
Duration: 80 minutes

Aids allowed: A pocket calculator with no communication ability. A single aid-sheet prepared by the student, no larger than 8.5"x11", written on both sides. A hard-copy English translation dictionary. A ruler.

- **Completely turn off** any communication device you may have and leave it with your belongings at the front of the room.
- **DO NOT separate the sheets of your question paper.** You can, however, "carefully" tear off the blank page at the end, as it does not have to be handed in.
- Before starting, please **PRINT IN BLOCK LETTERS your name, student number, and practical group code** at the top of this page **and** on the answer sheet.

Locate your test version number in the header at the top of the page and fill in the circle with the corresponding version code on your answer sheet in the "Form Code" box. Mark in your student number by shading the circles at the top-right of the sheet, starting with a 0 if the first digit is a 9. It is not required to bubble in your surname on the lower half of the sheet.

Scanned Area of the Answer Sheet:

1. **Use a dark-black, soft-lead pencil or a black pen.**
2. Indicate your answer to a multiple-choice question by thoroughly filling the appropriate circle on the answer sheet and also by recording your answer on the test paper.
3. If you wish to modify an answer, erase your pencil mark thoroughly.
4. **Do not write anything else on the answer sheet.** Use the blank sheets at the end or the back of the question sheets for rough work.

The test consists of **12** multiple-choice questions, worth 5 points each, or altogether 60 points. The test also has a set of free-form questions worth 40 points, for which fully worked solutions are required. The total possible number of points is 100.

Multiple-choice questions:

- Please choose the best answer.
- Blank or incorrect answers are worth zero points.
- Multiple answers for the same question result in zero points for that question.

Free-form Questions: To be awarded maximum credit, you must provide fully worked solutions to all parts of the free-form questions. In addition to showing your work, please put your answer(s) for each part in the boxes provided. You can use the back-side of the sheets and the blank pages at the end for your rough work which will not be graded or taken into account.

When the invigilators declare the test ended, **stop any writing or filling of circles** on the answer sheet immediately. Please put your answer sheet **inside your test paper** and have the paper ready for an invigilator to pick up.

MULTIPLE CHOICE [5 points per question × 12 questions = 60 points total]

Possibly helpful information for this test:
π = 3.14159 is the ratio of the circumference to the diameter of a circle
g = 9.80 m/s^2 is the acceleration due to gravity near the Earth's surface.

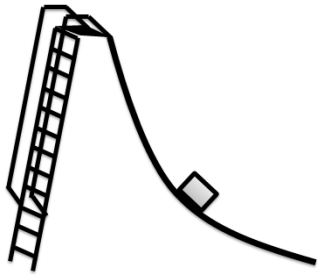
Common Prefixes:
k = "kilo-" = 10^3 c = "centi-" = 10^{-2} m = "milli-" = 10^{-3} μ = "micro-" = 10^{-6}
n = "nano-" = 10^{-9}

60 seconds = 1 minute; 60 minutes = 1 hour; 24 hours = 1 day; 365.25 days = 1 year
1 litre = 1000 cm^3

The quadratic equation: If $ax^2 + bx + c = 0$, then $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Air resistance may be neglected in all questions, unless otherwise stated.

Question 1



A box slides down a slippery, curved slide. Air resistance and friction are negligible. When the box is at the point shown in the drawing,

(A) the box is speeding up, but the magnitude of its acceleration is decreasing.
(B) the speed of the box is constant, but the magnitude of its acceleration is increasing.
(C) the speed of the box is constant, and the magnitude of its acceleration is also constant.
(D) the box is speeding up, but the magnitude of its acceleration is constant.
(E) the box is speeding up, and the magnitude of its acceleration is increasing.

Question 2

The eastward component of vector $\vec{A}$ is not zero, and it is equal to the westward component of vector $\vec{B}$. The northward components of $\vec{A}$ and $\vec{B}$ are equal, and not zero. Given this information, which one of the following statements about these two vectors must be correct?

(A) Vector $\vec{A}$ is perpendicular to vector $\vec{B}$.
(B) The magnitude of vector $\vec{A}$ is twice the magnitude of vector $\vec{B}$.
(C) The magnitude of vector $\vec{A}$ is equal to the magnitude of vector $\vec{B}$.
(D) Vectors $\vec{A}$ and $\vec{B}$ point in opposite directions.
(E) Vector $\vec{A}$ is parallel to vector $\vec{B}$.

Question 3

The position of an object as a function of time is given by $x = bt^2 - ct$. What is the instantaneous velocity of the object as a function of time?

(A) $2bt^2 - c$ (B) $(b - c)t$ (C) $\frac{bt^3}{3} - \frac{ct^2}{2}$ (D) $2bt - c$ (E) $bt^2 - ct$

Question 4

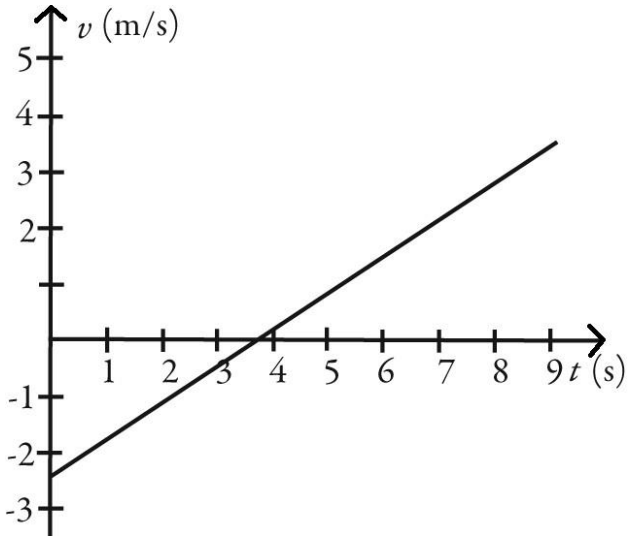
Your heart pumps approximately 80 cm^3 of blood with each beat. How many litres of blood will your heart pump during your lifetime? [Assume 70 beats/minute and a life span of 90 years.]

(A) 4×10^6 (B) 3×10^{11} (C) 3×10^8 (D) 1×10^7 (E) 5×10^5

Question 5

The motion of a particle is described in the velocity versus time graph shown in the figure. Over the time interval t = 0 to 9 seconds, we can say that its speed

(A) increases and then decreases.
(B) stays the same.
(C) decreases and then increases.
(D) decreases.
(E) increases.



Question 6

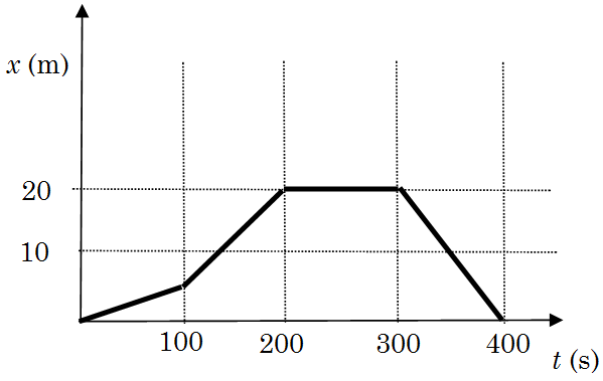
You wish to calculate the density of a solid sphere of foam by measuring its mass and diameter. Density = mass/volume, and the volume of a sphere = $\frac{\pi}{6}d^3$, where d is the diameter. You can measure the mass of the sphere of foam to a percentage error of 1%, and the diameter to a percentage error of 2%. What will be the percentage error in the density of foam that you compute?

(A) 3% (B) 6% (C) 4% (D) 2% (E) 1%

Question 7

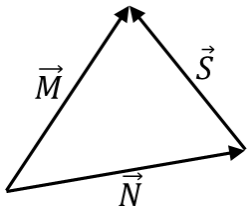
Peter goes for a walk along the x-axis. The walk takes him 400 seconds to complete. The graph below shows his position x as a function of time t. What was the average velocity of the walk?

(A) +11 m/s (B) zero
(C) +20 m/s (D) −0.2 m/s
(E) +0.1 m/s



Question 8

For the diagram shown, what is the vector $\vec{S}$ in terms of $\vec{M}$ and $\vec{N}$?



(A) $\vec{S} = \vec{M} + \vec{N}$ (B) $\vec{S} = \vec{N} \times \vec{M}$
(C) $\vec{S} = \vec{M} \times \vec{N}$ (D) $\vec{S} = \vec{N} - \vec{M}$
(E) $\vec{S} = \vec{M} - \vec{N}$

Question 9

You are counting the number of worms per bucket of dirt in a farmer's field. After counting the worms in *N* different buckets of dirt, you compute the estimated mean, $\bar{x}$, and estimated standard deviation, σ, of the numbers. If you continue your measurements until you have counted the numbers of worms in 100*N* buckets, what would you expect to be the standard deviation of the numbers?

(A) σ (B) $100\,\sigma$ (C) $10\,\sigma$ (D) $0.1\,\sigma$ (E) $0.01\,\sigma$

Question 10

A bullet pierces a sand bag 32 cm thick. If the initial bullet speed was 68 m/s and it emerged from the sandbag with a speed of 18 m/s, what is the magnitude of the acceleration the bullet experienced while it traveled through the bag? Assume the bullet has constant acceleration while in the bag.

(A) 160 m/s^2 (B) 6700 m/s^2 (C) 320 m/s^2 (D) 32 m/s^2 (E) 9.8 m/s^2

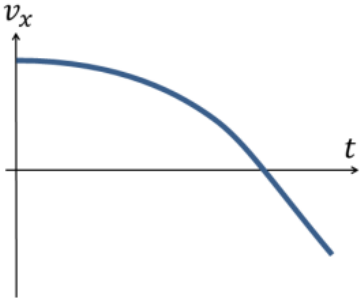
Question 11

An airplane starts from rest and has a constant acceleration of *a* along a runway that has a total length *L*. After traveling the full distance of the runway, the plane is traveling at its takeoff speed. What is the time t_{TO} needed to take off?

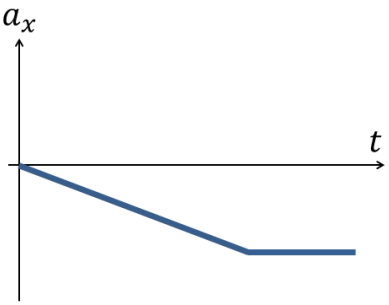
(A) $\frac{L}{a}$ (B) La (C) $\frac{2L}{a}$ (D) $\sqrt{\frac{L}{a}}$ (E) $\sqrt{\frac{2L}{a}}$

Question 12

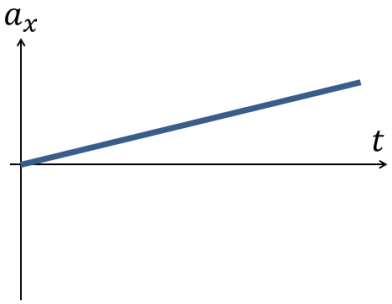
The velocity-versus-time graph for an object is shown to the right. Which figure below best represents the object's acceleration-versus-time graph?



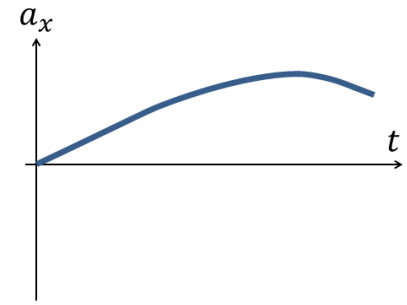
(A)



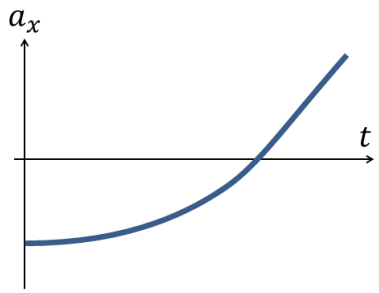
(B)



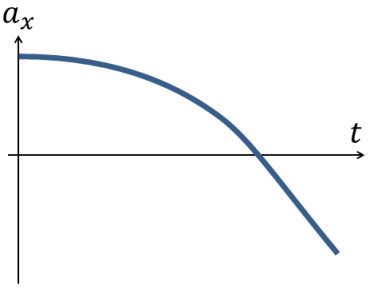
(C)



(D)



(E)



FREE-FORM PART (40 points total)
Clearly show your reasoning and work as some part marks may be awarded. Write your final answers in the boxes provided.

PART A
A toy rocket, initially at rest on the ground, accelerates straight upward with constant acceleration of 5.6 m/s^2. The acceleration period lasts for time 2.5 s until the fuel is exhausted. After that, the rocket is in free fall.

1. [**10 points**] What is the maximum height reached by the rocket?

$\pm$

2. [**10 points**] What is the time between the initial launch and when the rocket hits the ground again?

PART B

A research student on a farm counts the number of worms per bucket of dirt in a farmer's field. She counts the worms in six different equally-sized buckets, as recorded in the table below.

Number of worms:	70	80	89	68	103	71

1. [**16 points**] Based on these data, what is the mean number of worms per bucket? Be sure to include the error of the mean, and express both the mean and the error to the correct number of significant figures.

2. [**4 points**] How many of the six measurements lie within plus-or-minus one standard deviation of the mean?

ROUGH WORK (not marked)