



APEF

CURRICULUM

**JANUARY 2000**

**PHYSICS 12**

**EXAMINATION**

**Comment Box—For Use by Teacher**

What accommodations have been made?

By whom?

Position:

Why?



Name: \_\_\_\_\_



**LIST OF EQUATIONS (Assume quantities are vectors where appropriate.)**

- |   |   |                         |
|---|---|-------------------------|
| speed                                     | impulse   |                         |
| 1. $v_{\text{avg}} = \Delta d / \Delta t$ | 13. impulse = $F_{\text{avg}} t$  |                         |
| acceleration                              | momentum  |                         |
| 2. $a = (v_2 - v_1) / (t_2 - t_1)$        | 14. $p = mv$  |                         |
| distance                                  | impulse = change of momentum  |                         |
| 3. $d = v_1 t + \frac{1}{2} a t^2$        | 15. $F(t_2 - t_1) = (p_2 - p_1)$  |                         |
| speed                                     | conservation of momentum  |                         |
| 4. $v_2^2 = v_1^2 + 2ad$                  | 16. $m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$   |                         |
| average speed                             | conservation of energy  |                         |
| 5. $v_{\text{avg}} = (v_2 + v_1) / 2$     | 17. $\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2} m_1 v_1'^2 + \frac{1}{2} m_2 v_2'^2$ |                         |
| force                                     | work  |                         |
| 6. $F_{\text{net}} = ma$                  | 18. $W = Fd \cos \theta$  |                         |
| electric force                            | work  |                         |
| 7. $F_e = kq_1 q_2 / d^2$                 | 19. $W = mad$   |                         |
| gravitational force                       | kinetic energy  |                         |
| 8. $F_g = Gm_1 m_2 / d^2$                 | 20. $KE = \frac{1}{2} mv^2$   |                         |
| gravitational field strength              | potential energy  |                         |
| 9. $g = F/m$                              | 21. $PE_{\text{grav}} = mgh$  |                         |
| electric field strength                   | electric potential  |                         |
| 10. $E = F/q$                             | 22. $PE_{\text{elect}} = qEd$   |                         |
| centripetal acceleration                  | power   | centripetal force       |
| 11. $a_c = v^2/r$                         | 23. $P = W/t$   | 25. $F = mv^2/r$        |
| tangential speed                          | power   | coefficient of friction |
| 12. $v = 2\pi r/T$                        | 24. $P = (E_2 - E_1)/t$   | 26. $\mu = F_f/F_n$     |

**SOME IMPORTANT CONSTANTS**

1. Magnitude of the electron charge.....  $e = 1.60 \times 10^{-19} \text{ C}$
2. Vacuum permittivity.....  $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$
3. Coulomb's law constant .....  $k = 9.0 \times 10^9 \text{ Nm}^2/\text{C}^2$
4. Acceleration due to gravity at  
the Earth's surface .....  $g = 9.80 \text{ m/s}^2$
5. Universal Gravitational Constant .....  $G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$

**General Instructions**

This examination is composed of four (4) sections:

- Section 1**            30 multiple choice
- Section 2**            10 restricted short answer
- Section 3**            3 extended problem solving and/or  
                             intermediate essay question
- Section 4**            1 extended essay question

The estimated time allotment for each type of question is as follows:

**multiple choice**.....1 minute for each question (30 minutes total)  
**restricted short answer** ..... 3 minutes for each question (30 minutes total)  
**extended problem solving/intermediate essay**..15 minutes for each question (45 minutes total)  
**extended essay** .....25 minutes total  
(Include an additional 20 minutes for organization and extra writing time.)

**TOTAL TIME - 2 1/2 HOURS**

*Use these estimates to guide you in the completion of the examination. It is not necessary to spend the estimated time on each question. Plan your time so as to enable you to complete the examination.*

A complete examination requires that you do all questions.

**Students are permitted to use their own calculators.**

**All problems involving measurements must have the appropriate significant digits taken into account in the solution.**



## SECTION 1

## INSTRUCTIONS

Estimated Time - 30 minutes

Value 30 points

In this part of the examination, there are thirty (30) multiple choice questions, each with a value of one point. All numbers used in the question are to be considered as the result of a measurement.

Read each question carefully and decide which of the choices **best** answers the question asked. You are provided with a separate answer form. Fill in the space that corresponds to the choice. Use **HB pencil only**.

Fill in the answers to the multiple choice questions in this part of the examination in 1 to 30 of Section 1 on Side 1 of the Response Form supplied by the test administrator. At the completion of the examination, place the Response Form in the examination booklet.

## Example

## Answer sheet

Which unit is an SI unit of distance?

A	B	C	D
0	0	■	0

- A. feet
- B. inches
- C. metres
- D. cubits

If you wish to change an answer, erase your first mark completely.

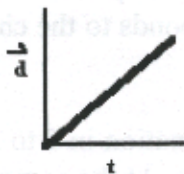
**Do not turn the page to start the examination until told to do so by the presiding examiner.**



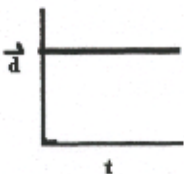
1. When can accelerated motion occur?
- A. only when speed changes
  - B. only when direction changes
  - C. when either speed or direction changes
  - D. only when both speed and direction change simultaneously

2. Which graph represents changing velocity?

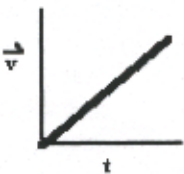
A.



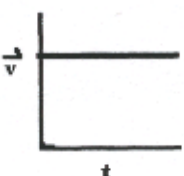
B.



C.



D.



3. d(m)	t(s)
0	0
2	1
8	2
18	3
32	4
50	5
69	6
89	7
110	8

The table above provides the displacement (d) at time (t) for the motion of an object. Which conclusion about the motion of the object is valid?

- A. When  $t = 3$  s, the speed is constant.
- B. The accelerated motion is positive throughout.
- C. After 6 s the acceleration changes.
- D. During the final three seconds the motion is constant.

4. Two trains meet on parallel tracks. Train A is headed west at  $80 \frac{\text{km}}{\text{h}}$  while train B travels east at  $100 \frac{\text{km}}{\text{h}}$ . If a passenger on train B is walking towards the rear of the train at  $5.0 \frac{\text{km}}{\text{h}}$ , what is the magnitude of the passenger's velocity relative to a person on train A?

- A.  $15 \frac{\text{km}}{\text{h}}$
- B.  $95 \frac{\text{km}}{\text{h}}$
- C.  $175 \frac{\text{km}}{\text{h}}$
- D.  $185 \frac{\text{km}}{\text{h}}$

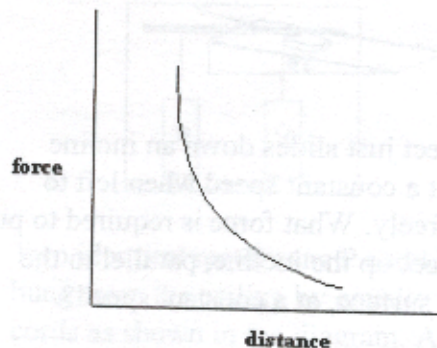


## PHYSICS EXAM

5. If two students pull on an object, what angle between the forces exerted by the students gives the greatest resultant force?
  - A.  $0^\circ$
  - B.  $45^\circ$
  - C.  $90^\circ$
  - D.  $180^\circ$
6. The gravitational force between two bodies is independent of which of the following?
  - A. surface areas
  - B. masses
  - C. relative positions
  - D. separation
7. Two bags of marbles are hung 1 m apart. Which would double the gravitational force between the bags?
  - A. double the number of marbles in one bag only
  - B. double the number of marbles in both bags
  - C. reduce the separation to 0.5 m
  - D. increase the separation to 2 m

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8.



The graph represents the force on a magnetic particle passing through a field of a reference magnet. Which best describes the variation of the force?

- A. varies directly with the distance
  - B. varies inversely with the distance
  - C. varies directly with the square of the distance
  - D. varies inversely with the square of the distance
9. What is the approximate weight of a 5-kg mass on the surface of the Earth?
- A. 0.5 N
  - B. 5 kg
  - C. 5 N
  - D. 5 N



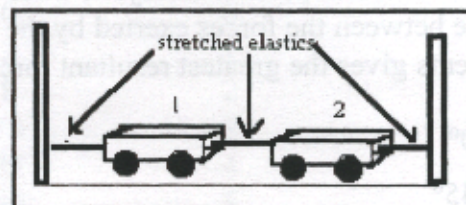
10.



An object just slides down an incline plane at a constant speed when left to move freely. What force is required to pull the object up the incline, parallel to the incline surface, at a constant speed?

- A. the tangent of the angle of incline multiplied by the force perpendicular to the plane
  - B. twice the force parallel to and down the plane
  - C. the force to overcome friction
  - D. twice the tangent of the angle of incline multiplied by the force parallel to the plane
11. Which physical properties are conserved in every collision?
- A. momentum only
  - B. kinetic energy only
  - C. momentum and kinetic energy
  - D. mass and velocity

12.

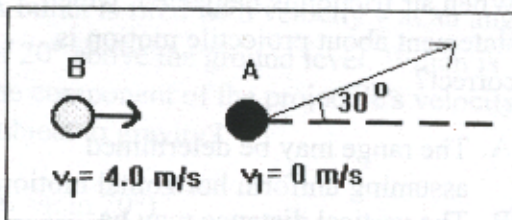


In the diagram given above, two frictionless carts of the same mass are resting on a horizontal surface. There are three elastic bands stretched and attached to the carts and a solid support as shown. What happens when the three elastics are cut at the same time?

- A. The two carts will move towards each other.
- B. The two carts will move away from each other.
- C. Cart 2 will have a greater speed than Cart 1.
- D. The carts remain as they are.



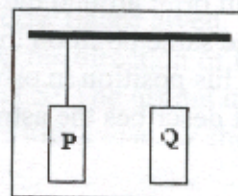
13.



A stationary puck A is struck by a puck B of the same mass, travelling at  $4.0 \frac{\text{m}}{\text{s}}$ . The collision is perfectly elastic. After the collision puck A moves off at an angle of  $30^\circ$  to the line of approach at a speed of  $3.5 \frac{\text{m}}{\text{s}}$ . What is the angle at which puck B travels after the collision, with respect to the line of approach?

- A.  $30^\circ$
- B.  $60^\circ$
- C.  $90^\circ$
- D.  $120^\circ$

14.



Two identical metal cans P and Q are hung from the ceiling by equally long cords as shown in the diagram. A jet of water is directed horizontally at each can for the same time (a fraction of a second). P is then seen to be moving much more rapidly than Q. Which statement is the best explanation of the original conditions?

- A. P had less energy than Q.
- B. P had less momentum than Q.
- C. P had less inertia than Q.
- D. P had more mass than Q.

15. What adjective describes the velocity of a rocket that just manages to move away from the Earth to travel to Venus?

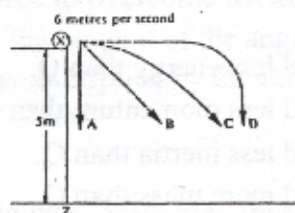
- A. escape
- B. critical
- C. maximum
- D. terminal



16. An astronaut in orbit around the Earth notices that the same point on the Earth is always below his position in orbit. What statement best describes the astronaut's motion?

A. The satellite motion is opposite to that of the Earth's rotation.  
 B. The satellite is at rest above the Earth.  
 C. The period of the satellite's orbit is identical to the Earth's.  
 D. The satellite's period of orbit is twice that of the Earth's.

17.

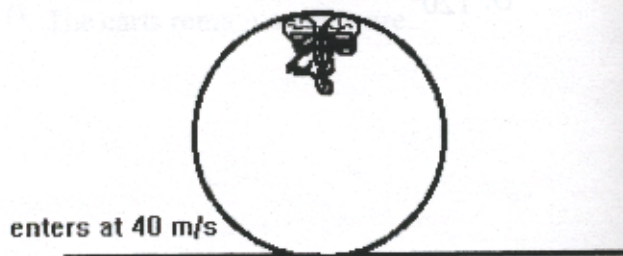


In the diagram above a ball X is initially 5 m above the ground. X is shot off the ledge horizontally with an initial velocity of  $6.0 \frac{\text{m}}{\text{s}}$ . Which of the dotted lines in the diagram best shows the path of X as it travels from its starting position?

A. A  
 B. B  
 C. C  
 D. D

18. When air friction is neglected, which statement about projectile motion is correct?
- A. The range may be determined assuming uniform horizontal motion.  
 B. The vertical distance may be determined assuming uniform vertical motion.  
 C. The time in air is dependent only on the range.  
 D. The acceleration may be considered uniform and positive, both horizontally and vertically.

19. A motorcyclist enters a loop-to-loop at a speed of 40 m/s and reaches the top of the loop with just enough speed ( $2 \frac{\text{m}}{\text{s}}$ ) to maintain the circular path of the loop-to-loop.



Which statement explains what happens if the speed at the top is slightly less than  $2 \frac{\text{m}}{\text{s}}$ ?

A. The motorcyclist falls down vertically.  
 B. The motorcyclist falls away from the track slightly.  
 C. The motorcyclist is pressed against the track a little more.  
 D. The motorcyclist will fall off the motorcycle.



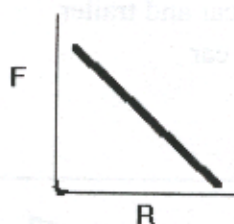
# PHYSICS EXAM

20. A bullet is fired with velocity  $v$  at an angle of  $20^\circ$  above the ground level. Which is the component of the projectile's velocity subject to gravity?

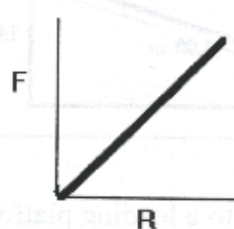
A.  $v(\sin 20^\circ)$   
 B.  $v(\tan 20^\circ)$   
 C.  $v(\cos 20^\circ)$   
 D.  $v(\cot 20^\circ)$

21. To make an object of mass  $M$  move at speed  $V$  around a circular path of radius  $R$ , a centripetal force  $F$  is required. Which graph best illustrates the relationship between the  $F$  and  $R$  variables, assuming the other variables remain constant?

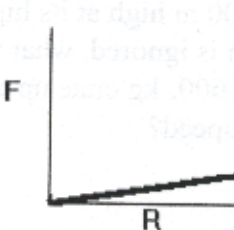
A.



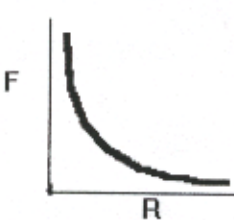
B.



C.



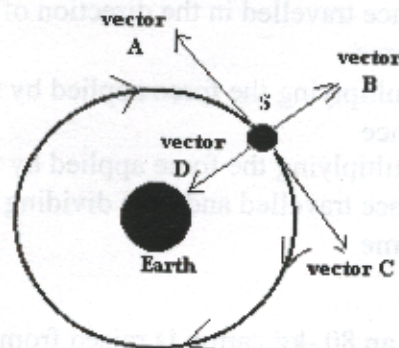
D.



# PHYSICS EXAM

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22. Based on the figure given, which vector represents the direction of the satellite's velocity at  $S$ ? The orbital direction of the satellite is clockwise, as shown.



A. vector A  
 B. vector B  
 C. vector C  
 D. vector D

23. Which demonstrates the scientific definition of work?

A. the motion of an object due to an applied force  
 B. the motion of an object perpendicular to the applied force  
 C. the object's movement on a horizontal surface  
 D. the resistance of an object to motion because of its inertia

# APEF CURRICULUM



## PHYSICS EXAM

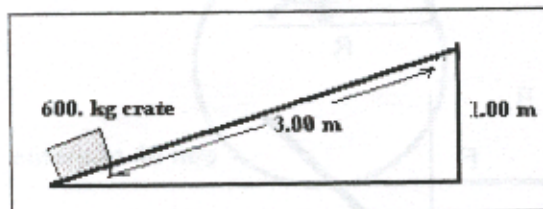
24. How is work done on an object calculated?
- by dividing the force applied by the distance travelled
  - by multiplying the force applied by the distance travelled in the direction of the force
  - by multiplying the force applied by the distance
  - by multiplying the force applied by the distance travelled and then dividing by the time
25. In Banff an 80.-kg carton is raised from the ground and placed on a truck. The floor of the truck is 1.2 m above the ground. Which factor contributes most to the change in potential energy?
- the altitude of Banff
  - the direction of motion relative to the vertical
  - the speed of the motion
  - the vertical height moved
26. Which of the following is equivalent to one watt?
- 1 Ns
  - $1 \frac{\text{N}}{\text{s}}$
  - $1 \frac{\text{J}}{\text{s}}$
  - 1 Nm

## PHYSICS EXAM

## APEF CURRICULUM

27. A bird of mass 2.0 kg is flying at a speed of  $5.0 \frac{\text{m}}{\text{s}}$ . What is its kinetic energy?
10. J
  25. J
  50. J
  - $1.0 \times 10^2 \text{ J}$
28. A trailer is towed 400 m along a level road at constant speed against a resistive force of 0.5 N per kilogram. In order to calculate the work performed on the trailer against the effects of friction, what additional data is required?
- the mass of the car
  - the mass of the trailer
  - the mass of the car and trailer
  - the speed of the car

29.



A ramp leading up to a loading platform is 3.00 m long and 1.00 m high at its highest point. If the friction is ignored, what work is needed to slide a 600.-kg crate up the ramp at a constant speed?

- $2.00 \times 10^2 \text{ J}$
- $5.89 \times 10^2 \text{ J}$
- $1.80 \times 10^3 \text{ J}$
- $5.88 \times 10^3 \text{ J}$

## APEF CURRICULUM



30. A clay ball of mass ' $m$ ' moving with a velocity  $v$  strikes another clay ball of mass ' $3m$ ', initially at rest. The balls stick together after the collision. What is the velocity of the combined mass after the collision?

A.  $0.25v$   
B.  $0.50v$   
C.  $1.0v$   
D.  $2.0v$

#### Standard Short Answer Example

A ball takes  $1.60\text{ s}$  to reach the water when dropped from a bridge. Calculate the distance the bridge is above the water.

Show your work in the space below. Example Only

$$v = u + at$$

$$0 = 0 + (9.81\text{ m/s}^2)(t)$$

$$t = 1.60\text{ s}$$



## SECTION 2

## INSTRUCTIONS

Estimated Times - 30 minutes

Value - 30 points

In this section of the examination there are 10 questions. The questions are **restricted short answer**. Each question has a value of **3 points** with an estimated time of 3 minutes for each.

It is expected that the answers will be written out in complete sentences, and terminology appropriate to physics is to be used when explanations or descriptions are required. When mathematical solutions are required, complete solutions are to be given.

Note: Units and significant figures will be considered when marking.

**Restricted Short Answer - Example**

A ball takes 2.00 s to reach the water when dropped from a bridge. Calculate the distance the bridge is above the water.

Write your answer in the space below**Sample Only**

$$d = v_i t + (1/2)at^2$$

$$d = 0 + (1/2)(9.80 \text{ m/s}^2)(2 \text{ s})^2$$

$$d = 19.6 \text{ m}$$



1. a. In the equation  $v_2 = v_1 + at$ , the term ' $a$ ' must turn out to be what physics quantity?

Explain. (1.5 points)

- b. Assuming  $v_1$  is equal to  $v_2$ , what does this tell us about the motion of the object? Explain your answer in with reference to the term ' $a$ '. (1.5 points)

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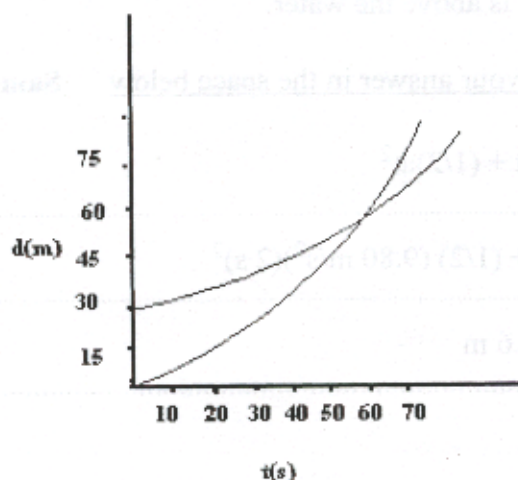
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2. The graph to the right shows two objects accelerating at the beginning of a race.

- a. Give an appropriate interpretation of the vertical distance between the curves. (1.5 points)

- b. What is the interpretation of the graph, in relation to the position of the objects, at the point the curves intersect? (1.5 points)



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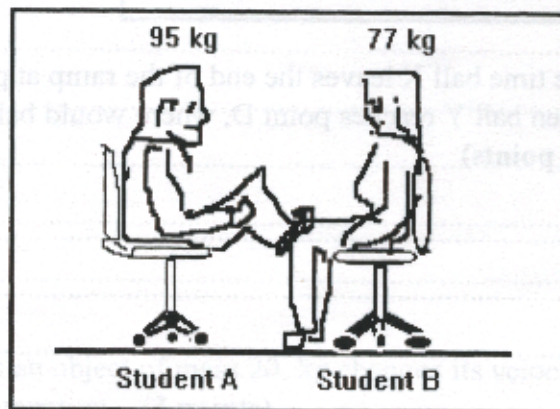
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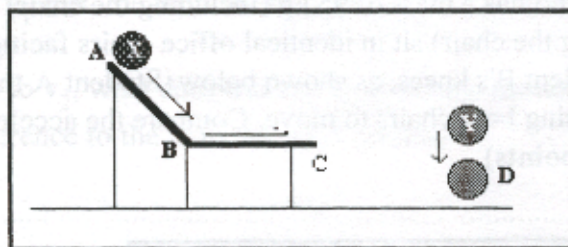
3. Two students, student A who has a mass of 95 kg (including the chair) and a student B who has a mass of 77 kg (including the chair) sit in identical office chairs facing each other. Student A places his bare feet on student B's knees, as shown below. Student A then suddenly pushes outward with his feet, causing both chairs to move. Compare the acceleration of each student. Show your reasoning. (3 points)



4. Estimate to the nearest power of ten, the force of electrostatic attraction between two adults standing side-by-side if  $2.0 \times 10^{-6} \text{ C}$  of charge has been transferred from one person to another. (3 points)



5.



Examine the diagram above. At the time ball X leaves the end of the ramp at point C, ball Y is dropped from the same height. When ball Y reaches point D, where would ball X be relative to the floor? Give your reasoning. (3 points)

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6. The centripetal acceleration required to keep an object moving in a horizontal circular path at constant speed is related to the velocity and the radius of orbit.
- a. To what is centripetal acceleration directly proportional? Explain. (1 point)
- b. If this variable to which centripetal acceleration is directly proportional were to triple, how would this affect the magnitude of the centripetal acceleration? Show calculations. (2 points)

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7. To make an object of mass ' $m$ ' move at speed ' $v$ ' around a circular path of radius ' $r$ ', a centripetal force ' $F$ ' is required. Sketch the graph of the relationship between force and velocity. Explain this graphical relationship.

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8. A force acting on an object of mass 20. kg changes its velocity from  $10\frac{m}{s}$  to  $20\frac{m}{s}$ . Determine the change in momentum. (3 points)

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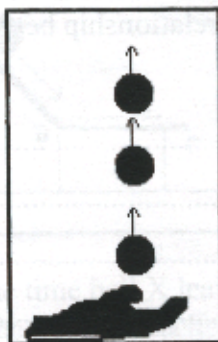
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9.



A ball is thrown vertically upward. As the ball moves upward, do the following quantities, related to the ball, increase, decrease or remain the same: force of gravity, potential energy, kinetic energy? Explain. (3 points)

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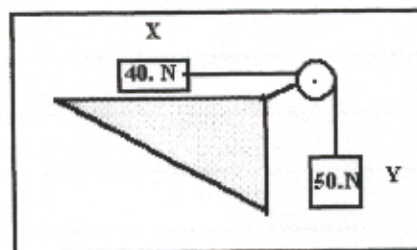
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10.



A 40.-N weight, X, and a 50.-N weight, Y, are joined together by a light cord that passes over a pulley. Y is released and allowed to fall 0.50 m. What is the change of the system's potential energy, in joules? (3 points)



## SECTION 3

## INSTRUCTIONS

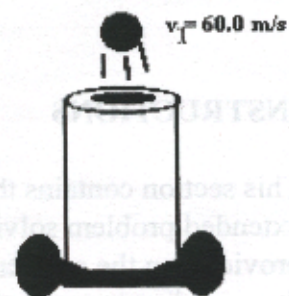
Estimated Time - 45 minutes

Value - 24 points

This section contains three question with a value of **8 points each**. These questions are either extended problem solving or intermediate essays. Answers are to be constructed in the space provided on the answer sheet. If there is insufficient room or you need to redo a question, ask the presiding examiner to provide you with additional paper. This paper can be inserted into the answer booklet.

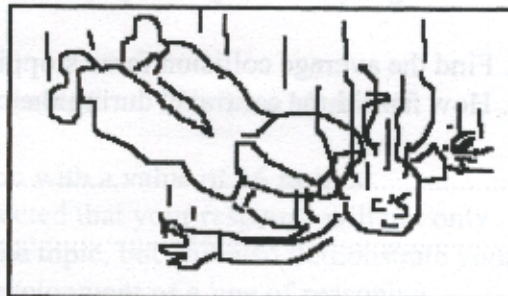


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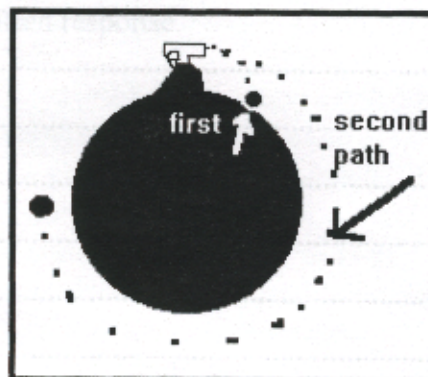




2. a. A student skydiver falls through the air.  
Explain how and why the acceleration changes due to air friction as the student descends. Your explanation should include Newton's law(s) to clarify your reasoning. (Assume 'g' remains constant.) **(3 points)**



- b. Would there ever be a point, while falling, at which there would be zero acceleration? Explain the condition of motion of the student if this point is ever reached. **(2 points)**



- c. A cannonball is fired horizontally from a tall mountain to the ground below. Because of gravity, it strikes the ground with increased speed. A second cannonball is fired fast enough to go into circular orbit, but gravity does not increase its speed. Why? **(3 points)**

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## SECTION 4

## INSTRUCTIONS

Estimated Time - 25 minutes

Value - 16 points

This section is composed of one extended essay question with a value of **16 points**.

Since this is a higher level reasoning question, it is expected that your response will not only contain the appropriate physics information related to the topic, but will also demonstrate your ability to write an organized response that shows the development of a line of reasoning appropriate to the issue given in the question. It is also expected that you will demonstrate an effective style of writing in the development of your written response.



1. Read the article below and write an essay following the guidelines provided.

### Bicycle Helmet Safety

Institutes set standards for bicycle safety. One possible safety test procedure is to drop a bicycle helmet, containing a 5.0 kg, rigid model of a human head, onto a flat, hard surface from a height of 1.5 m to 2.0 m. If the acceleration of the model is more than 300 g's, the helmet cannot be certified. A 2.0 m drop has the same effect as a 20 km/h impact. Any direct impact over 20 km/h is likely to result in death. During a serious collision, 'g' forces will often exceed 300 g's.

Consider these two parts of the helmet: the outer shell and the liner. The helmet's outer shell is designed to make the effect of an impact less harmful by spreading the force over a greater area of the head and by reducing friction in a slide. Some helmet liners, however, are made of stiff foam. They require a certain minimum force before they start to absorb the impact and begin to crush. Until this minimum is reached, the head must absorb the impact. After minimum is reached, the helmet's liner absorbs energy until either (1) all the remaining energy is absorbed or (2) the liner has been crushed to its minimum thickness. When the blow is of such severity that the liner gets crushed to its minimum thickness, the remaining energy is absorbed by the head, which is likely to be lethal. Even though the helmet is designed to limit the impact, this impact is not reduced much below a lethal level; that is, anything from a serious concussion to a coma. Any impact of greater severity than received in a typical fall could be fatal.

The medical profession now believes that even lesser accelerations can produce serious injuries. Because the human head is less rigid than the foam liner, it starts to absorb the impact before the liner starts to crush. also, tests exclude any possibility of measuring what might happen inside the skull when an impact causes brain tissues to contort, rotate, and tear.

However, it is unlikely that helmet standards will be changed to provide significant protection because the industry doesn't believe that consumers would buy the resulting products. Critics insist that because a rigid model head has to be used, test procedures are unable to simulate the effect on the bone and soft tissue in a human head. In the test, the foam liner starts to crush immediately upon impact--unlike in real life. The result is that manufacturers are making helmets that optimize padding stiffness, even though softer padding could provide better overall protection. In Canada, manufacturers have begun to use softer padding in helmets.



Making reference to the information provided on bicycle helmet safety (page 23), write a well-developed, argumentative essay that

- (1) shows how technology helps or hinders finding solutions to helmet construction with reference to its structure and function
- (2) describes or illustrates with examples and/or formulae the physics concepts related to a collision, and
- (3) explores the social and personal consequences (advantages and disadvantages) of creating new standards for equipment use.

Scoring:

technology--4 points

physics--4 points

social--4 points

overall development of argument--4 points

Total: 16 points