GRICS

554-534

Physics

Comprehensive Exam
Number 55

GUIDE

Secondary 5

September, 2005

Youth Sector General Education

1. GENERAL INFORMATION

1.1 Program: Physics, Secondary V

1.2 Origin: Mathematics and Science & Technology Committee, 2005

Computerization and graphics: Design Team and
Martine Sanscartier, Société GRICS
Revision : Patricia Juliano, BIM, Société GRICS

1.3 Time allotted: 2 hours 30 minutes

1.4 Number of questions: 27 distributed as follows:
15 multiple choice
12 constructed response

1.5 Authorized materials:
- drawing instruments, graph paper
- list of formulas and quantities included
- scientific calculator with or without a graphic display

2. DESCRIPTION OF EXAM

The following table matches each of the examination questions with the corresponding dimension of the definition of the domain that was used for the examination.

Exam Specifications

Modules / Skill	Nature of Light 44%	Mechanics 56%
Mastery of Concepts 36%	1, 2, 3, 4	8, 9, 10, 11, 12
Mastery of Applications 28% or 32% or 36%	5, 6, 7	13, 14, 15
Mastery of Problem-Solving Techniques 28% or 32% or 36%	17, 18, 19, 20 (16A) (4 of 5)	23, 24, 25, 26, 27 (21A) (22A) (6 of 7)

These percentages have been derived on the basis of the marks allotted for each question.
Although this table indicates that there are 27 questions, the student is required to answer only 25 of them. For questions 16, 17, 18, 19 and 20, the student is required to answer only four of the five. For questions 21, 22, 23, 24, 25, 26 and 27, the student is required to answer six of the seven.

ITEM SPECIFICATIONS

Question		MOD.TO.IO	T	S	D
Part A					
1	[2142]	M01.01.01	M	C	E
2	[2143]	M01.02.06	M	C	E
3	[2144]	M01.03.03	M	C	M
4	[2145]	M01.05.09	M	C	E
5	[2146]	M01.01.02	M	A	M
6	[2147]	M01.04.04	M	A	M
7	[2148]	M01.05.04	M	A	M
8	[2149]	M03.01.05	M	C	E
9	[2150]	M03.01.06	M	C	M
10	[2151]	M03.03.03	M	C	E
11	[2152]	M03.04.01	M	C	M
12	[2153]	M03.05.01	M	C	E
13	[2154]	M03.02.03	M	A	M
14	[2155]	M03.03.05	M	A	D
15	[2156]	M03.05.02	M	A	M
Part B					
16	[2157]	M01.02.05	E	A	M
17	[2158]	M01.03.08	E	P	E
18	[2159]	M01.04.06	E	P	M
19	[2160]	M01.03.07	E	P	M
20	[2161]	M01.05.13	E	P	D
Part C					
21	[2162]	M03.04.08	E	A	E
22	[2163]	M03.06.01	E	A	M
23	[2164]	M03.02.08	E	P	D
24	[2165]	M03.03.09	E	P	M
25	[2166]	M03.04.08	E	P	M
26	[2167]	M03.05.05	E	P	M
27	[2168]	M03.06.04	E	P	D

Legend:

MOD : Modules — M01: Nature of Light; M03: Mechanics

TO : Terminal objective

IO : Intermediate objective

T : Type — M: multiple choice; E: extended answer (constructed response)

S : Skill — C: Mastery of Concepts; A: Mastery of Applications; P: Mastery of Problem-Solving Techniques

D : Level of difficulty — E: Easy; M: Medium; D: Difficult

3- CORRECTION KEY

Part A

4 marks or 0 marks

1 C

2 B

3 B

4 D

5 D

6 C

7 A

8 B

9 C

10 A

11 B

12 A

13 C

14 D

15 A

GUIDELINES FOR CORRECTING CONSTRUCTED-RESPONSE QUESTIONS

The marking scale for correcting the answers to the constructed-response questions of the examination is presented below, along with explanations of the terms used in the scale.

It is **IMPORTANT** that the teacher read this information carefully before correcting the examination.

Constructed-response questions usually consist of two parts: the **procedure** used to solve the problem and the **answer**. Thus, a constructed-response question should be corrected in two steps.

Step 1

Analyze the work to understand the procedure used by the student, and then decide if the procedure is appropriate or not.

A **procedure** is **appropriate** if the steps presented could lead to the correct answer.

A **procedure** is **partially appropriate** if the steps presented do not lead to the correct answer, but include at least one step that is relevant and correct.

A **procedure** is **inappropriate** if none of the steps presented are relevant or if the student has not shown any work.

Step 2

If the procedure is deemed appropriate, then evaluate the answer. If the answer is incorrect, identify the type of error made.

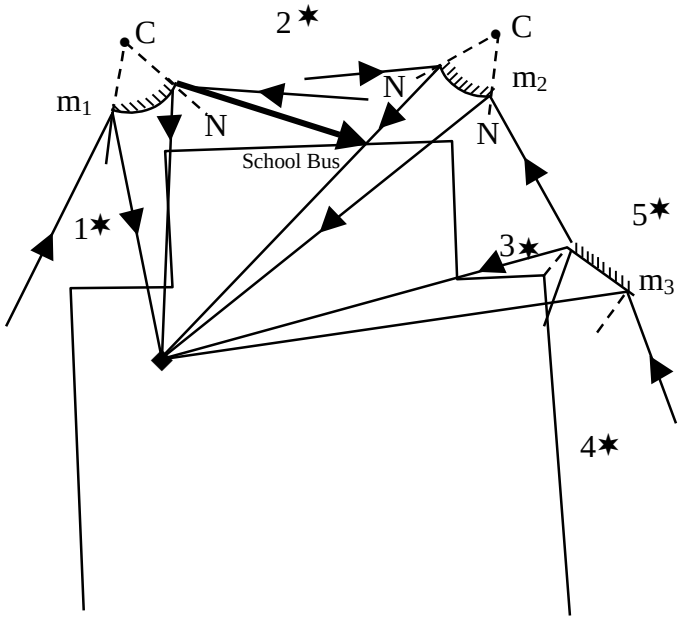
The **error** is considered **minor** if it is an error in calculation or transcription, if the unit of measurement is incorrect or missing, or if the student has rounded off a number incorrectly.

The **error** is considered **major** if a law, rule, or formula has been applied incorrectly.

No marks are allotted for a correct answer when the procedure used is inappropriate.

Part B

16 **Example of an appropriate and complete answer**



Answer: The bus driver cannot see students 2 and 5.

4 marks 3 proper field of vision diagrams and 2 students are correctly identified.

3 marks 3 proper field of vision diagrams and 1 student correctly identified.

2 marks 2 proper field of vision diagrams and 1 student identified.

1 mark 1 proper field of vision diagram.

0 marks The student showed no work (even if the answer is correct) or chose an inappropriate procedure.

Note: The bus blocks the ray from mirror 1, therefore student 5 cannot be seen.

17 **Example of an appropriate and complete answer**

From the diagram, the angle of incidence is 40° and the refracted angle is 23°.
Using Snell's Law gives an index of refraction of 1.65.

Putting this value into the critical angle calculation gives $\sin^{-1}\left(\frac{1}{1.65}\right) = \theta$

Therefore the critical angle is 37.3°.

This corresponds to Flint Glass.

Answer: The gem is made of Flint Glass.

4 marks Fully correct conclusion and calculation.

3 marks Method correct but mirror error in transcription or calculation leading to wrong conclusion.

2 marks Calculates refractive index but does not link to critical angle.

1 mark Does not apply.

0 marks No appropriate response.

18 **Example of an appropriate and complete answer**

Since this is a question that asks students to explain their critical thinking and analysis, answers may vary in format. Sketches are an appropriate alternative; however, a short written justification is also required.

Concepts to be included:

1. Optical power
   Definition of *P*, the optical power

2. Focal length
   Determine *f* from *P*
   $P = 0$ d $\rightarrow f = \infty$, therefore no curvature; the lens combination is similar to a rectangular prism. The combined action of the lenses is that light rays entering the lenses are not bent at the exit.

   Substituting $f = \infty$, in the thin lens equation, $d_o = -d_i$

3. Magnification
   Using the magnification equation, $M = -\frac{d_i}{d_o} = 1$; or no image is formed.

Conclusion: The focal point is located at an infinite distance from the lenses. The set of lenses acts like a block of glass with no curvature. There is no magnification ($M = 1$).

Answer: Sophie is right.

4 marks The student made the correlation between the 3 concepts, optical power, focal length and magnification, which led to correct conclusions.

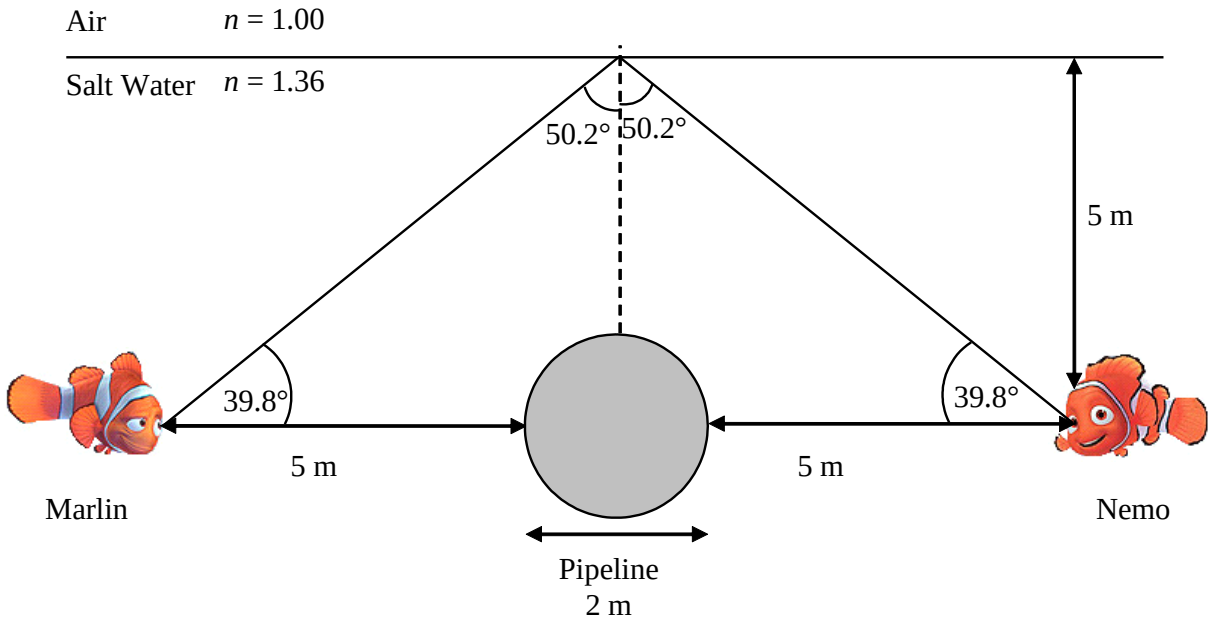
3 marks The student established the correlation between the 3 concepts; however, one of the conclusions is incorrect.

2 marks The student discussed the 3 concepts but did not come to a satisfactory conclusion, making major errors in applying the concepts.

1 mark The student's procedure was partially appropriate. The student discussed the impact of at least two of the 3 concepts.

0 marks The student gave no explanation or gave an inappropriate explanation.

19 **Example of an appropriate and complete answer**



Tan θ: $\frac{\text{opposite}}{\text{adjacent}} = \frac{5}{6}$

Therefore $\theta = 39.8^{o}$

Corresponding angle at water surface: 50.2^{o}

Critical angle: $\sin^{-1}\left(\frac{1}{1.36}\right) = 47.3°$

Answer: Marlin and Nemo can see each other because of total internal reflection.

Justification: As the complimentary angle exceeds the critical angle, total internal reflection occurs.

4 marks	Correctly drawn ray diagram; reference to total internal reflection; appropriate calculations.
3 marks	As above but simple arithmetical error.
2 marks	As above but pipeline diameter not taken into account, leading to incorrect conclusion.
1 mark	Recognizes total internal reflection is involved but no meaningful attempt made at justification. **(e.g. Only ray diagram completed.)**
0 marks	No appropriate response.

20 **Example of an appropriate and complete answer**

f = 12.0 cm
d_o = x
d_i = 64.0 – x

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{12.0} = \frac{1}{x} + \frac{1}{64.0 - x}$$

$$\frac{1}{12.0} = \frac{64.0 - x}{(x)(64.0 - x)} + \frac{x}{(x)(64.0 - x)}$$

$$\frac{1}{12.0} = \frac{64.0}{(x)(64.0 - x)}$$

$$\frac{1}{12.0} = \frac{64.0}{64.0x - x^2}$$

$64.0x - x^2 = 768$

$x^2 - 64.0x + 768 = 0$
$(x - 16)\ (x - 48) = 0$
d_o = 16.0 cm or 48.0 cm

$$M = -\frac{d_i}{d_o} = \frac{h_i}{h_o} > 1$$

$\therefore\ d_i > d_o$

Answer: Nadia must place the lens **16.0 cm** from the object.

4 marks Quadratic formula correctly solved and correct answer is identified.
3 marks Quadratic formula correctly solved but both 16.0 cm and 48.0 cm are identified as answers.
2 marks Major mathematical error in factoring or in obtaining a common denominator.
1 mark No quadratic equation determined; however, process is partially right.
0 marks The student showed no work or chose an inappropriate procedure.

Part C

21 **Example of an appropriate and complete answer**

$F - f = F_{net}$
$245\ N - 135\ N = 110\ N$

$F_{net} = ma$
$110\ N = (\ 50.0\ kg)(a)$
$\frac{110\ N}{50.0\ kg} = a$
$2.2\ m/s^2 = a$

Answer: Kaya's acceleration down the slope is $2.2\ m/s^2$.

4 marks The student chose an appropriate procedure and applied it correctly; the final answer is correct.

3 marks The student chose an appropriate procedure, but made minor errors in applying it.

2 marks The student chose an appropriate procedure, but made major errors in applying it, (e.g. Student neglects to subtract the frictional force from the force down the slope.)

1 mark The student's procedure was partially appropriate but made a major error in calculation.

0 marks The student showed no work (even if the answer is correct) or chose an inappropriate procedure; the answer is missing or incorrect, or it is correct purely by chance.

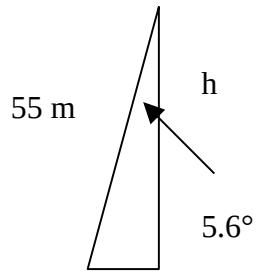
22 **Example of an appropriate and complete answer**

$m = 5.0 \times 10^{-1}$ kg
Height of tower

$$293 \text{ steps} \times \frac{1.88 \times 10^{1} \text{ cm}}{\text{step}} \times \frac{1.0 \text{ m}}{100 \text{ cm}} = 55 \text{ m}$$

Solve for *W*

The work done, *W*, is equal to the gain of potential gravitational energy.



The vertical height is a component of the height of the tower.

$h = 55 \text{ m} \times \cos 5.6°$
$h = 54.74$ m

Work done on cannon ball

$W = mgh$
$= (5.0 \times 10^{1})\ (9.8 \text{ m/s}^2)(54.74 \text{ m})$
$= 268.2$ J

Answer: The work done by Galileo on the cannon ball is **268 J**.

4 marks The student chose an appropriate procedure and applied it correctly; the final answer is correct.

3 marks The student chose an appropriate procedure, but made minor errors in applying it (i.e. calculations or transcription errors, incorrect units of measure, numbers rounded incorrectly).

2 marks The student chose an appropriate procedure, but made major errors in applying it (i.e. not taking the leaning angle into consideration or other errors relating to methods, rules, laws, systems or theories.)

1 mark The student's procedure was partially appropriate (Answer does not lead to the correct answer, but at least one of the steps is relevant and presented correctly. i.e. calculating only the height of the steps.)

0 marks The student showed no work (even if the answer is correct) or chose an inappropriate procedure.

23 **Example of an appropriate and complete answer**

Step 1: Determine the speed when the object first contacts the spring.

$V_2^2 = V_1^2 + 2a\Delta d$
$V_2^2 = 0 + 2(-9.8)(5)$
$V_2 = 9.9$ m/s

Step 2 Determine the force on the object from the spring upon compression of 0.15 m.

$F = kX$
$F = (4000)\ (0.15)$
$F = 600$ N

Step 3 Determine the average force from the moment of contact with the spring to 0.15 m of compression.

$$\frac{(0\text{ N} + 600\text{ N})}{2} = 300\text{ N}$$

Step 4 Determine the acceleration (deceleration) the object undergoes using Newton's 2nd Law.

$F = ma$
$a = \frac{F}{m}$
$a = \frac{300}{3}$
$a = -100$ m/s^2

Step 5 Calculate V_2 at a distance of 0.15 m with an initial speed of 9.9 m/s and an acceleration of 100 m/s^2.

$V_2^2 = 9.9^2 + (2)(-100)(0.15)$
$V_2 = 8.25$ m/s

Answer: The speed of the block was **8.3 m/s**.

4 marks The student chose an appropriate procedure and applied it correctly; the final answer is correct.

3 marks The student chose an appropriate procedure, but made minor errors in applying it (i.e. calculations or transcription errors, incorrect units of measure, numbers rounded incorrectly).

2 marks The student chose an appropriate procedure, but made major errors in applying it (i.e. not using average force (step 3)) or other errors relating to methods, rules, laws, systems or theories.

1 mark The student's procedure was partially appropriate (Does not lead to the correct answer, but at least one of the steps is relevant and presented correctly, i.e. only calculating speed as it contacts the spring.)

0 marks The student showed no work (even if the answer is correct) or chose an inappropriate procedure.

24 **Example of an appropriate and complete answer**

Acceleration at 400 seconds

Slope between 200 seconds and 800 seconds

$$a = \frac{v_f - v_i}{\Delta t}$$
$$= \frac{30.0 \text{ m/s} - 30.0 \text{ m/s}}{(8.00 \times 10^2 \text{ s} - 2.00 \times 10^2 \text{ s})}$$
$$= 0 \text{ m/s}^2$$

Answer: Ali's acceleration at 400 seconds is **0 m/s^2**.

Acceleration at 1200 seconds

Slope between 800 seconds and 1400 seconds

$$a = \frac{v_f - v_i}{\Delta t}$$
$$= \frac{-20.0 \text{ m/s} - 30.0 \text{ m/s}}{(1.40 \times 10^3 \text{ s} - 8.00 \times 10^2 \text{ s})}$$
$$= -8.3 \times 10^{-2} \text{ m/s}^2$$

Answer: Ali's acceleration at 1200 seconds is **-8.3×10^{-2} m/s^2**.

Displacement between 800 seconds and 1160 seconds

$$\Delta d = \frac{1}{2} \text{ (base} \times \text{height)}$$
$$= \frac{1}{2} (30.0 \text{ m/s} - 0 \text{ m/s}) (1.16 \times 10^3 \text{ s} - 8.00 \times 10^2 \text{ s})$$
$$= \mathbf{5.40 \times 10^3 \text{ m}}$$

Displacement between 1160 seconds and 1400 seconds

$$\Delta d = \frac{1}{2} \text{ (base} \times \text{height)}$$
$$= \frac{1}{2} (-20.0 \text{ m/s} - 0 \text{ m/s}) (1.40 \times 10^3 \text{ s} - 1.16 \times 10^3 \text{ s})$$
$$= \mathbf{-2.40 \times 10^3 \text{ m}}$$

Displacement between 800 seconds and 1400 seconds

5.40×10^3 m + ($- 2.40 \times 10^3$ m) = **3.00×10^3 m**

Answer: Ali's displacement between 800 seconds and 1400 seconds is **3.00×10^3m**.

4 marks All three responses are correct.

3 marks The displacement and one acceleration were correctly determined.

2 marks Both accelerations are correct.

1 mark Only one acceleration is correct.

0 marks The student showed no work or chose an inappropriate procedure.

25 **Example of an appropriate and complete answer**

Step 1: Calculate acceleration using *V* vs. *T* graph and P_1 (0,0), P_2 (4.0, 34)

$$\frac{\Delta Y}{\Delta X} = \frac{34}{3.8}$$

$$= 8.95 \text{ m/s}^2$$

Step 2: Using Newton's 2nd Law

$F = ma$

m = 1288 (from manufacturer's specs) and a = 8.95 m/s^2

$= 1288 \times 8.95$
$= 11\,524$ N
$= 1.2 \times 10^4$ N

Answer: The net force required is **1.2×10^4 N**.

4 marks The student chose an appropriate procedure and applied it correctly; the final answer is correct.

3 marks The student chose an appropriate procedure, but made minor errors in applying it (i.e. calculations or transcription errors, incorrect units of measure, numbers rounded incorrectly).

2 marks The student chose an appropriate procedure, but made major errors in applying it (i.e. errors relating to methods, rules, laws, systems or theories.)

1 mark The student's procedure was partially appropriate (i.e. it does not lead to the correct answer, but at least one of the steps is relevant and presented correctly.)

0 marks The student showed no work or chose an inappropriate procedure.

26 **Example of an appropriate and complete answer**

Note: This problem is composed of two simple machines, an inclined plane and a set of pulleys. There are at *least* 3 different approaches for a solution:

1. Solving the problem separately as two different machines
2. Multiplying the mechanical advantages of the two machines and solving the problem as one combined machine
3. Using an energy approach.

Solution 1 (2 separate machine entities)

Inclined Plane
In this problem IMA = AMA, no friction present.

$$\text{IMA} = \frac{\text{length of slope}}{\text{height of slope}}$$

$$= \frac{3.0\,\text{m}}{1.5\,\text{m}}$$

$$= 2.0$$

$$\text{IMA} = \text{AMA}$$

$$= \frac{mg}{F_E}$$

$$2.0 = \frac{(500\,\text{kg})(9.8\ \text{m/s}^2)}{F_E}$$

$$F_E = 2450\ \text{N}$$

Set of pulleys

IMA = 3 = number of supporting ropes; IMA = AMA, no friction

$$\text{AMA} = \frac{F_R}{F_E}$$

$$3 = \frac{2450\ \text{kg}}{F_E}$$

$$F_E = 816.67\ \text{N}$$

Solution 2 (1 complex machine)

IMA for the inclined plane = 2, IMA for the set of pulleys = 3

Combined IMA = 2 × 3 = 6 IMA = AMA, no friction

$$\text{AMA} = \frac{mg}{F_E}$$

$$\text{AMA} = \frac{(500\,\text{kg})(9.8\,\text{m/s}^2)}{F_E}$$

$$6 = \frac{(500\,\text{kg})(9.8\,\text{m/s}^2)}{F_E}$$

$$F_E = 816.67\ \text{N}$$

Solution 3 (Energy)

The gain in potential gravitational energy by the boat = work done by the winch

$mgh = F \times d$

$(500\ \text{kg})(9.8\ \text{m/s}^2)(1.5\ \text{m}) = F\,(3(3.0\ \text{m}))$
$F = 816.67\ \text{N}$

Answer: The minimum force applied by the winch to pull the boat out of the water is **817 N**.

Note: Other trigonometric or scale diagram solutions are also acceptable.

4 marks The student chose an appropriate procedure and applied it correctly; the final answer is correct.

3 marks The student chose an appropriate procedure, but made minor errors in applying it (i.e. calculations or transcription errors, incorrect units of measure, numbers rounded incorrectly).

2 marks The student chose an appropriate procedure, but made major errors in applying it (i.e. not tripling the length of cable being pulled by the winch or other errors relating to methods, rules, laws, systems or theories.)

1 mark The student's procedure was partially appropriate. (Procedure does not lead to the correct answer, but at least one of the steps is relevant and presented correctly. i.e. only calculating work for one simple machine.)

0 marks The student showed no work or chose an inappropriate procedure.

27 **Example of an appropriate and complete answer**

By observation, the counterbalance acts remove the mass of the elevator in the solution.

Power input is 4000 W but motor is only 70 % efficient so useful power is (0.7)(4000) = 2800 W

$P = \frac{W}{t}$ and $W = F \times d$ so $P = \frac{Fd}{t}$

So we know that the elevator moves 5 m every second (5 m/s) using a certain force.

$\therefore \quad 2800\ \text{W} = \frac{F5}{1\,\text{s}}$

$F = \frac{2800}{5}$

$= 560\ \text{N}$

$F = 5.6 \times 10^2\ \text{N}$

Answer: The magnitude of the force against which the motor is working is 5.6×10^2 N.

4 marks The student chose an appropriate procedure and applied it correctly; the final answer is correct.

3 marks The student chose an appropriate procedure, but made minor errors in applying it (i.e. calculations or transcription errors, incorrect units of measure, numbers rounded incorrectly).

2 marks The student chose an appropriate procedure, but made major errors in applying it (i.e. errors relating to methods, rules, laws, systems or theories.)

1 mark The student's procedure was partially appropriate (i.e. it does not lead to the correct answer, but at least one of the steps is relevant and presented correctly.)

0 marks The student showed no work or chose an inappropriate procedure.

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554-534

Physics

Comprehensive Exam
Number 55

Question Booklet

Secondary 5

September, 2005

Youth Sector General Education

INSTRUCTIONS

1. Write the required information on the title page of the Answer Booklet.

2. Answer all questions in the Answer Booklet. Each question is worth four marks.

3. In Part B, you are to answer 4 of the 5 questions.

4. In Part C, you are to answer 6 of the 7 questions.

5. You may use drawing instruments, graph paper and a scientific calculator with or without a graphic display.

6. You may refer to the lists of formulas and quantities included in this Question Booklet. The use of any other reference material is strictly forbidden.

7. Hand in both the Question Booklet and the Answer Booklet at the end of the exam session.

Note: Figures are **NOT** necessarily drawn to scale.

Time allotted: 2 hours 30 minutes

EQUATIONS

OPTICS

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$M = \frac{h_i}{h_o}$$

$$\frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

$$P = \frac{1}{f}$$

$$P_t = P_1 + P_2 + ... + P_n$$

MECHANICS

$$v_{av} = \frac{\Delta d}{\Delta t}$$

$$a = \frac{\Delta v}{\Delta t}$$

$$\Delta d = v_1 \Delta t + \frac{1}{2} a (\Delta t)^2$$

$$v_2 = v_1 + a\Delta t$$

$$v_2^2 = v_1^2 + 2a\Delta d$$

$$P = \frac{W}{\Delta t}$$

$$W = F\ \Delta d$$

$$F_E l_E = F_R l_R$$

$$E_g = mgh$$

$$E_k = \frac{1}{2} m v^2$$

$$F_E \Delta d_E = F_R \Delta d_R$$

$$F = ma$$

$$F_g = mg$$

$$F = kx$$

MATHEMATICS

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

PHYSICAL CONSTANTS

SYMBOL	QUANTITY	VALUE
c	Speed of light in a vacuum	3.00×10^8 m/s
g	Acceleration due to gravity (earth)	9.8 m/s^2

PART A

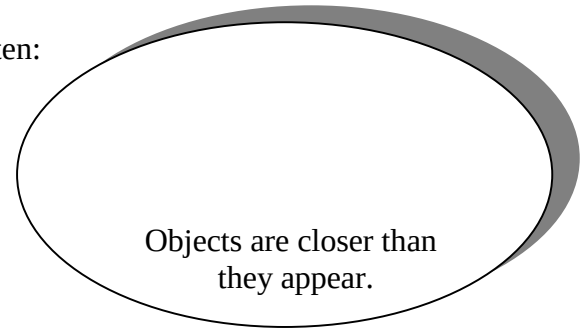
Questions 1 to 15
Blacken the letter that corresponds to your answer in the Answer Booklet.

1 **Which of the following light phenomena accounts for the colours in a rainbow?**

A) Diffraction
B) Diffusion
C) Dispersion
D) Reflection

2 The following diagram depicts a side-view mirror of a car.

On the mirror is written:

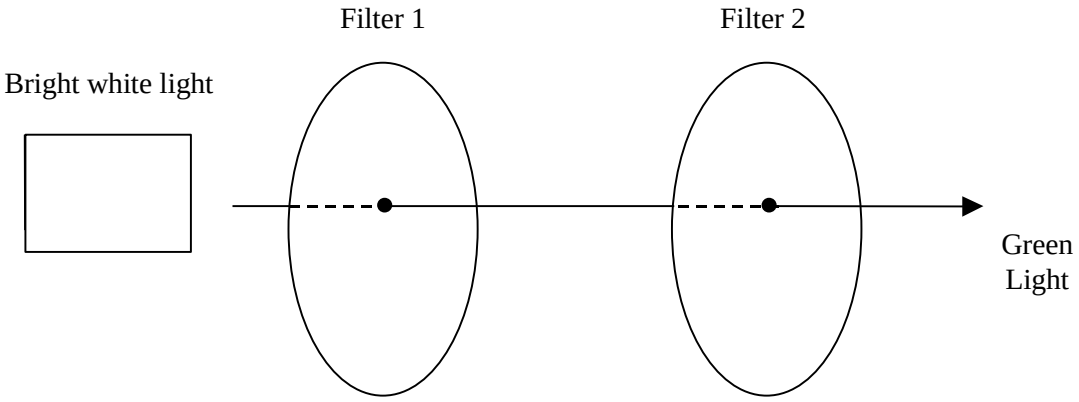


What type of mirror would produce this effect?

A) Plane
B) Convex
C) Converging
D) Concave

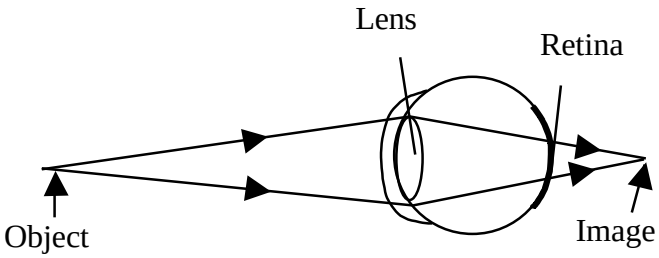
3 A bright white stage light has two filters of different colours placed in front of it.

What combination of filters would produce green light?



	Filter 1	**Filter 2**
A)	Blue	Red
B)	Blue	Yellow
C)	Orange	Violet
D)	Yellow	Red

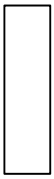
4 Julie came back from the ophthalmologist who told her she is suffering from hyperopia, a condition in which images are formed behind the retina in the eye.



Hyperopia

Which one of the following correction lenses would help Julie?

A) Plane



C) Convex-concave

B) Plano-concave

D) Concavo-convex

5 A pinhole camera was set up to view a 5.0 cm matchstick.

The distance to the matchstick was twice the depth of the camera.

What was the height of the image on the screen?

A) 50.0 cm

B) 10.0 cm

C) 5.0 cm

D) 2.5 cm

6 A student carries out an experiment to determine the focal length of five lenses.

The results are shown in the following table.

Lens	Focal length in (cm)
A	+15
B	+25
C	-15
D	-25
E	-2.67

What lens or combination of lenses should the student use to get an overall power of -2.67 d?

A) Lens E Only

B) Lens A and Lens D

C) Lens B and Lens C

D) Lens C and Lens D

7 Haran is manipulating a concave mirror that has a focal length of 10.0 cm. His physics teacher tells him that the difference between d_o and d_i is 15.0 cm and that the image is larger than the object and has a negative magnification.

Where should Haran place the object to obtain the desired image?

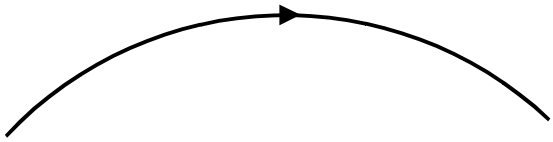
A) d_o = 15.0 cm and d_i = 30.0 cm

B) d_o = 30.0 cm and d_i = 15.0 cm

C) d_o = 5.0 cm and d_i = -10.0 cm

D) d_o = 10.0 cm and d_i = -5.0 cm

8 The following path was traced by an object during an experiment in a laboratory.



When observed from a stationary vantage point, which of the following would NOT cause the trajectory above?

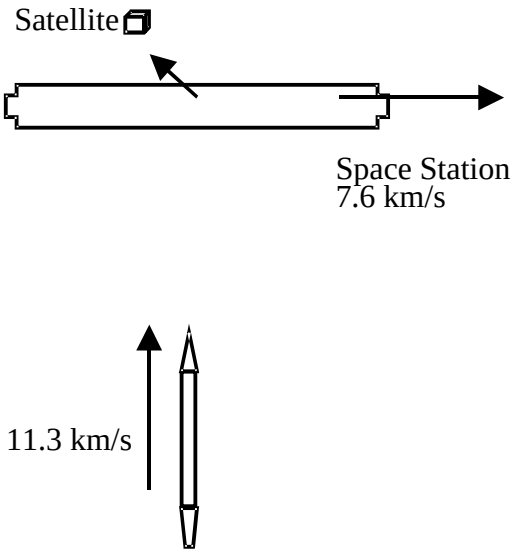
A) A goal kick from the soccer goal keeper, into the air, towards the half way line

B) A package dropped from a plane flying horizontally

C) An arrow shot upwards at an angle of 45 degrees

D) A kangaroo hopping along a path

9 The International Space Station (ISS) orbits in space at a velocity of 7.6 km/s. During one of their missions, the astronauts onboard the station launched a satellite with a velocity vector, as shown below. Seconds after the launch, the satellite stopped working. A rocket was immediately launched from Earth to retrieve the satellite.



Given the following:

- The escape velocity of the rocket to leave Earth's gravitational pull is 11.3 km/s vertically.
- The space station was directly over the rocket-launching platform **at the time the space station was launched**.
- The magnitude of the satellite's velocity vector is less than that of the space station.

Which of the following velocity vectors represents the direction that the rocket takes to reach the disabled satellite?

A) 

C) 

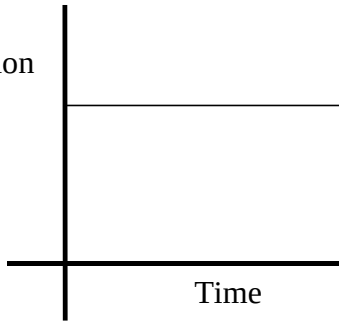
B) 

D) 

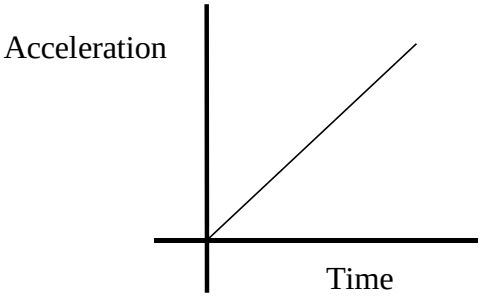
10 A student dropped an object vertically and measured the time it took for the object to fall a certain distance. She collected her data and proceeded to analyze it. One of the graphs she plotted was acceleration vs. time.

Which graph corresponds to her experiment?

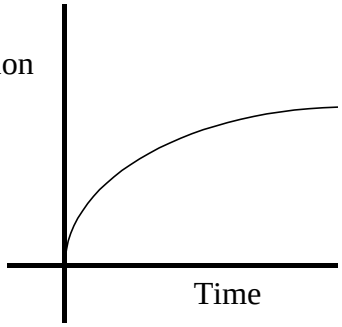
A)



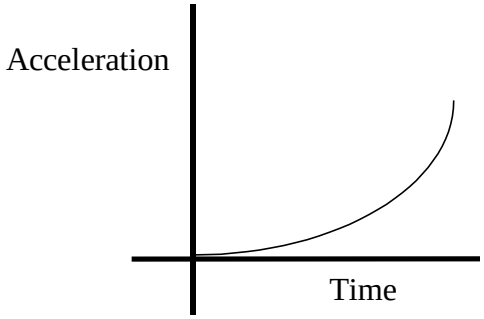
C)



B)



D)



11 Veena is running at a constant speed on a treadmill.

Which of the following statements is FALSE?

A) Gravity is acting on Veena.

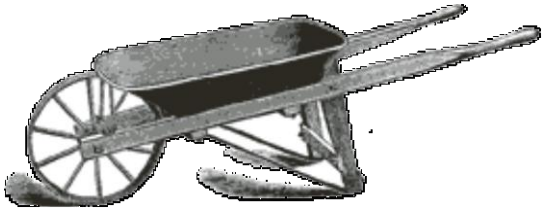
B) Veena experiences a positive net force.

C) The treadmill is pushing against Veena.

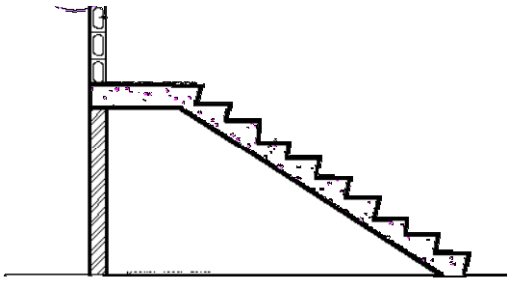
D) Frictional force exists in this situation.

12 The following diagrams represent simple machines found in our environment.

Arm 

Wheelbarrow 

Nutcracker 

Staircase 

Which combination correctly pairs the object with its simple machine?

A) Arm – Lever

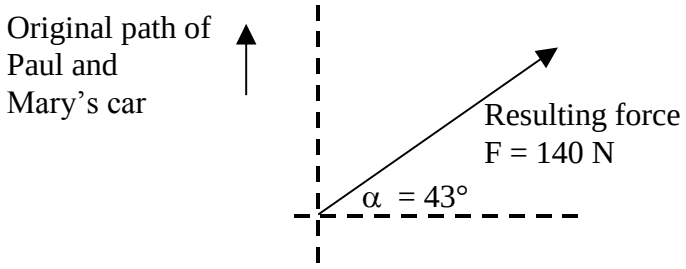
B) Wheelbarrow – Pulley

C) Nutcracker – Wheel and Axle

D) Staircase – Wedge

13 While at the country fair, Paul and Mary chose to share a bumper car.

Paul and Mary's 480-kg car is accelerating at a rate of 0.20 m/s^2. A 350-kg car bumps into them from the left. The resulting force on Paul and Mary's car is shown below.



What was the acceleration of the second car prior to the collision?

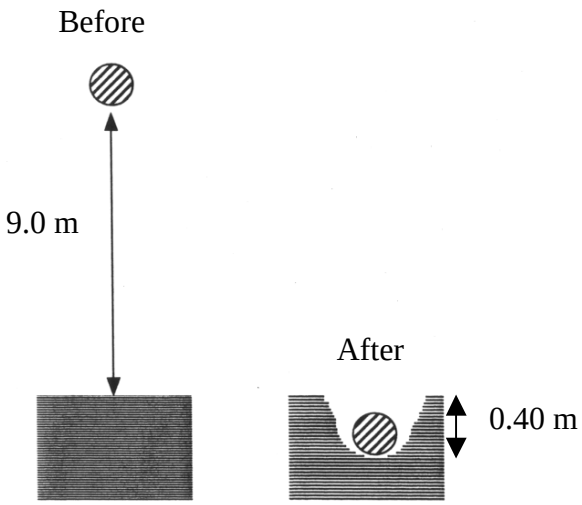
A) 0.21 m/s^2 to the right

B) 0.21 m/s^2 to the left

C) 0.29 m/s^2 to the right

D) 0.29 m/s^2 to the left

14 Moria dropped a heavy object from a height of 9.0 m above a pile of cardboard. After the object came to a stop, Moria determined that the cardboard was deformed to a depth of 0.40 m.



What resulting deceleration did the object undergo while in contact with the cardboard?

A) 1.3×10^0 m/s^2

B) 9.8×10^0 m/s^2

C) 1.3×10^1 m/s^2

D) 2.2×10^2 m/s^2

15 The great pyramid of Cheops is 146 m high. Workers used large stones to build this structure. Each stone had a mass of 900 kg.

Egyptologists believe that ramps were used to raise the stones to the height needed. It is thought that 6 workers, each pushing with 400 N force, could accomplish this task.

Neglecting friction, what would be the length of the ramp needed to get each stone to the top of the pyramid?

A) 5.37×10^2 m

B) 2.40×10^3 m

C) 3.22×10^3 m

D) 1.29×10^6 m

In Parts B and C of the examination you must show all your work. Answer all these questions in the answer booklet. Show all the work needed to solve the problem: **data given, explanations, formulas** and **calculations**. Then write your answer in the space provided. You will be given no marks if you provide the right answer without showing your work. However, you will be given part marks for work that is partially correct. Where necessary, corrections will take into account the units of measurement.

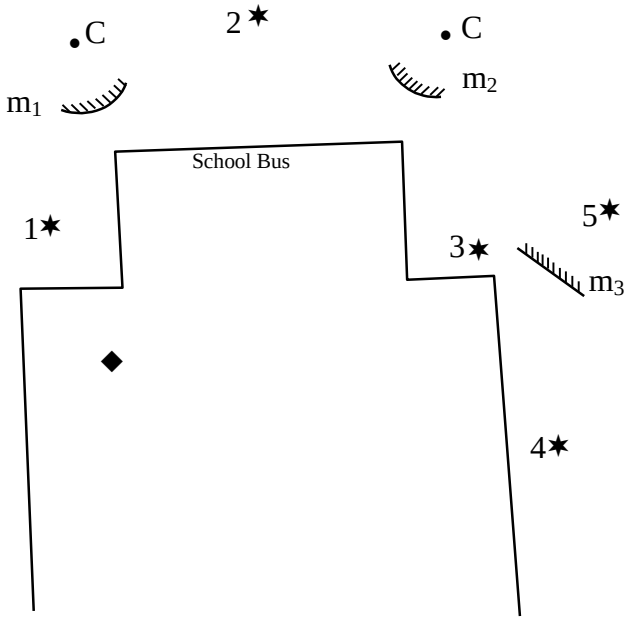
PART B

Questions 16, 17, 18, 19 and 20 (Answer four questions only.)

If you answer all questions in this section, **draw a line through the question that you do not want to have corrected**. If you do not, questions 16, 17, 18 and 19 will be corrected.

16 Using three mirrors, a school bus driver is able to view students leaving the bus. One plane mirror and two convex mirrors are shown in the following diagram. There are 5 students surrounding the bus.

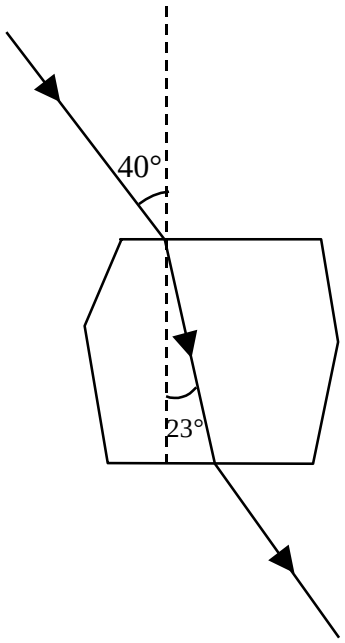
Symbols: ◆ Represents the driver's eye.
✶ Represents the students.
• C Represents the centre of curvature.



Construct field of vision diagram, identifying the student(s) the driver CANNOT see in the mirrors.

17 A physicist buys a "diamond" ring from a street vendor for $50. He knows the gem is unlikely to be diamond and conducts an experiment to measure its angles of incidence and refraction.

The results are:



The physicist has access to a data table showing critical angles for a range of substances.

Substance	Critical angle
Quartz	43.2°
Flint glass	37.3°
Zircon	31.4°
Diamond	24.5°

What substance is the gem made of?

Explain your reasoning.

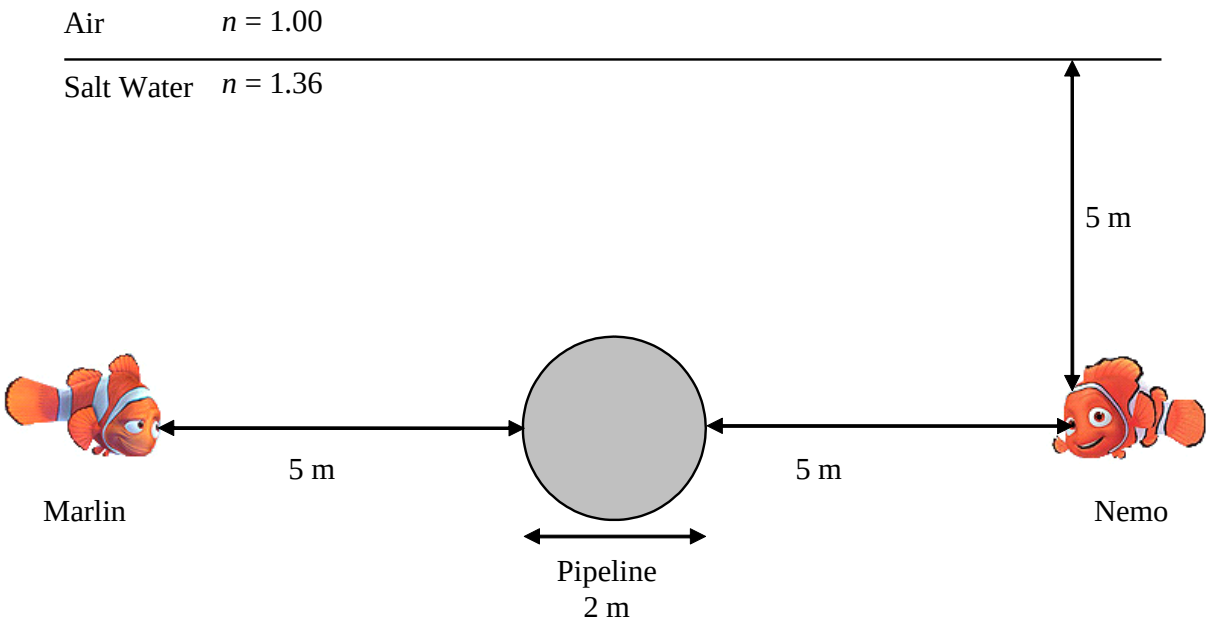
18 During an experiment on optical power and lens combinations, Sophie came up with a calculated optical power of 0 dioptres for a set of two lenses. Hassan, her lab partner, concluded that the result could not be possible.

Who is right?

How would you justify your answer from an optics point of view? Support your answer, in a short written justification, using all three of the following concepts:

- **optical power**
- **focal length**
- **magnification**

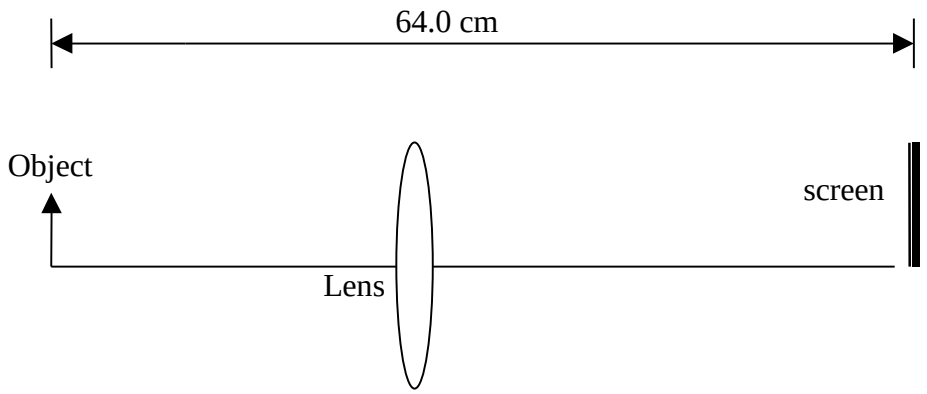
19 Both Marlin and Nemo are at a depth of 5 metres, and each is 5 metres away from a 2-metre diameter pipeline that lies between them.



By means of a fully labelled ray diagram and appropriate calculations, explain how it is possible for Marlin and Nemo to see each other from their present positions.

Justify your answer.

20 Nadia is conducting a physics experiment using a converging lens on an optical bench. The professor has said that the object must be 64.0 cm from the screen. Nadia is told that the focal length of the lens is 12.0 cm.



How far from the object must Nadia place the lens to obtain a clear and larger image on the screen?

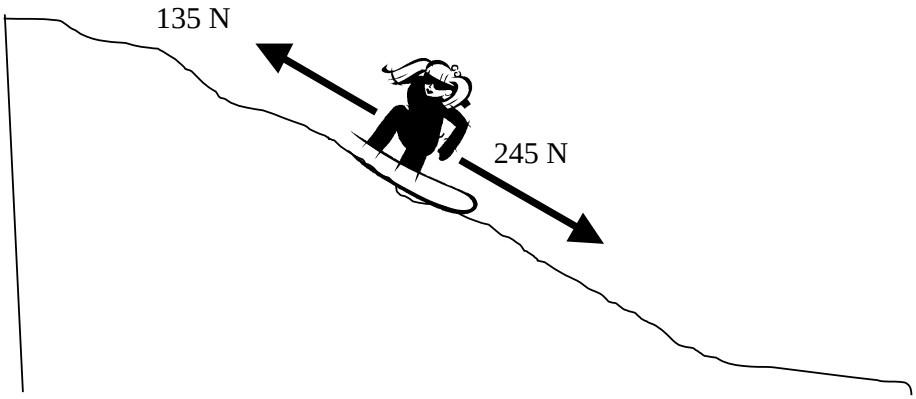
Show all your work.

PART C

Questions 21, 22, 23, 24, 25, 26 and 27 (Answer six questions only.)

If you answer all questions in this section, **draw a line through the question that you do not want to have corrected**. If you do not, questions 21, 22, 23, 24, 25 and 26 will be corrected.

21 Kaya is snow boarding down a mountain slope. The force pulling her down the run is 245 N, while the frictional force acting up the slope is 135 N. Kaya has a mass of 50.0 kg.

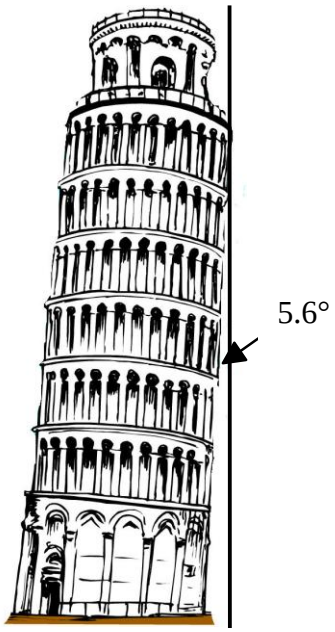


What is her acceleration down the slope?

22 According to legend, Galileo Galilei conducted an experiment to prove that two objects of different mass would fall at the same rate, by dropping two cannon balls from the top of the Tower of Pisa.

Galileo carried a 5.00×10^{-1} kg cannon ball up the 293 steps leading to the bell tower, climbing two steps at a time.

Consider that the tower was already leaning at an angle of 5.6^{o} and the dimensions of the steps are 2.05×10^{1} cm deep by 1.88×10^{1} cm high.



How much work did Galileo do in carrying the cannon ball?

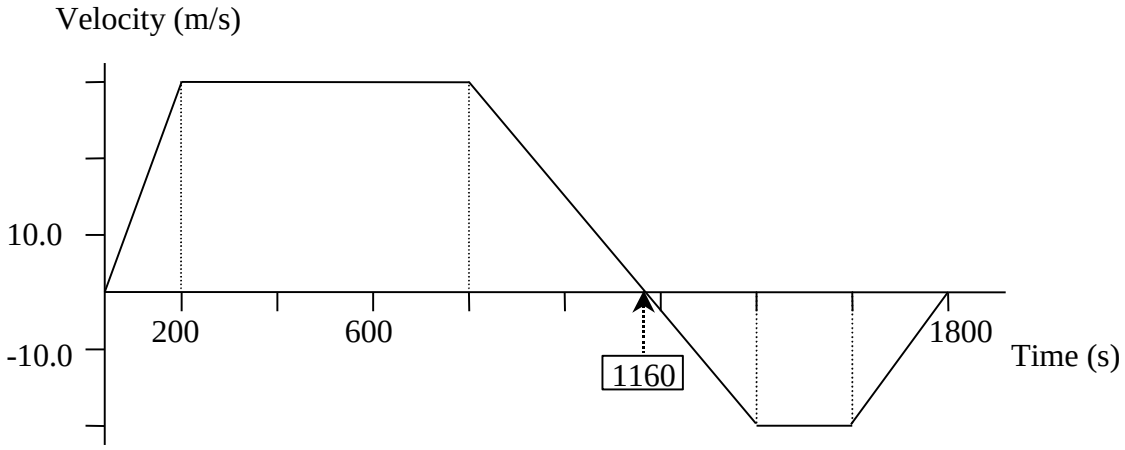
23 A 3.0 kg block is dropped from a height of 5.0 m onto a spring with a spring constant (K) 4.0×10^3 N/m.

When the block is momentarily at rest, the spring is compressed by 0.27 m.

What was the speed of the block when the compression of the spring was 0.15 m?

24 Ali is participating in the Tour de l'Île bicycle marathon held each year on the island of Montreal. The following velocity versus time graph represents Ali's course over a period of 1800 seconds.

Velocity-time Graph of Ali's Bicycle Race



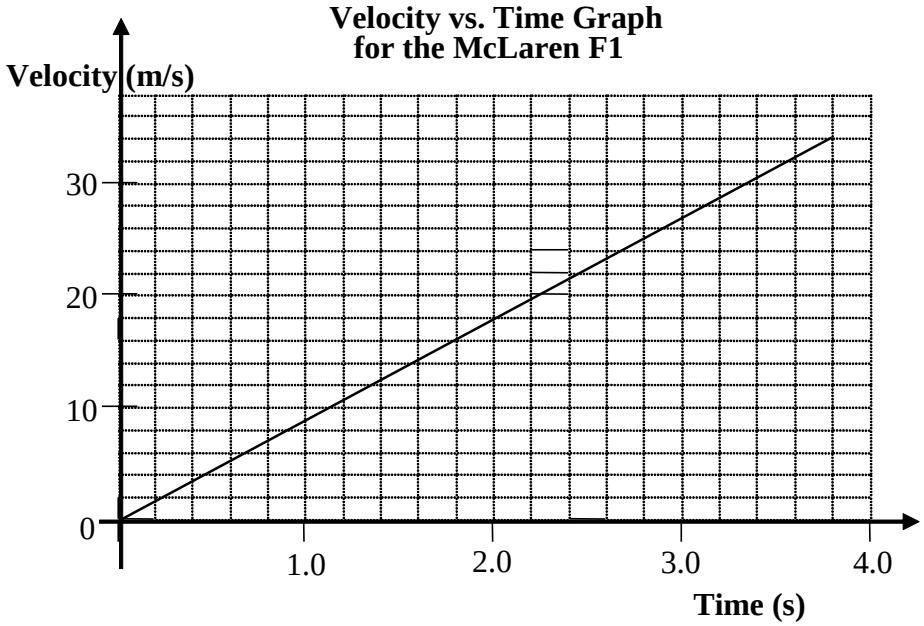
From the graph determine the following:

1. **Ali's acceleration at 400 seconds.**
2. **Ali's acceleration at 1200 seconds.**
3. **Ali's displacement during the period between 800 seconds and 1400 seconds into the ride.**

25 As a physicist, Vince has been asked to test the new McLaren F1 automobile. The automobile maker provided the following specifications for the car.

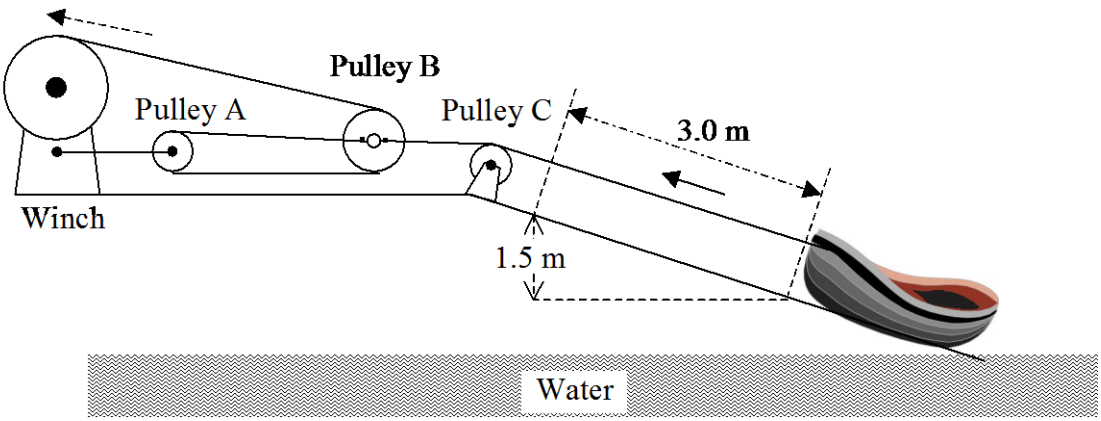
Price:	$890 000
L/ 100km :	19.6
Mass:	1288 kg
Layout:	Mid-Engine/RWD
Transmission:	6-Speed Manual
Engine	
Type:	V12
Displacement:	6064 cc
Horsepower:	627 bhp @ 7400 rpm
Redline:	7500 rpm

Vince performed some tests on the car and plotted the following velocity versus time graph after his experiment.



What net force is required by this car to produce the graph above?

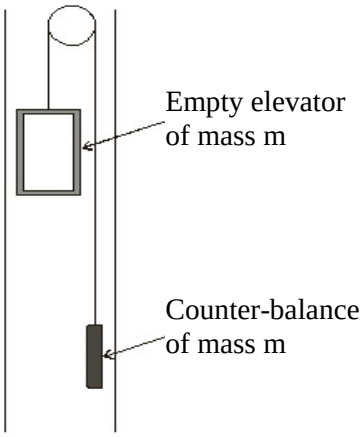
26 An electric winch is used to pull a 5.0×10^2 kg boat along a sloped jetty 3.0 m onto its trailer.



What is the minimum force applied by the winch to pull the boat up the last 3 metres of the jetty? Assume friction is negligible.

Show all your work.

27 An elevator motor is moving an empty elevator upwards at a speed of 5.0 m/s, as shown below. The power input to the motor is 4.0 kW. The motor is 70% efficient.



What is the magnitude of the force (friction plus air resistance) against which the motor is working?

GRICS

554-534

Physics

Comprehensive Exam
Number 55

Answer Booklet

Secondary 5

September, 2005

Student's Name	
Group	Date

Youth Sector General Education

PART A

Questions 1 to 15
Blacken the letter that corresponds to your answer.
Each question is worth four marks.

1 [A] [B] [C] [D]

2 [A] [B] [C] [D]

3 [A] [B] [C] [D]

4 [A] [B] [C] [D]

5 [A] [B] [C] [D]

6 [A] [B] [C] [D]

7 [A] [B] [C] [D]

8 [A] [B] [C] [D]

9 [A] [B] [C] [D]

10 [A] [B] [C] [D]

11 [A] [B] [C] [D]

12 [A] [B] [C] [D]

13 [A] [B] [C] [D]

14 [A] [B] [C] [D]

15 [A] [B] [C] [D]

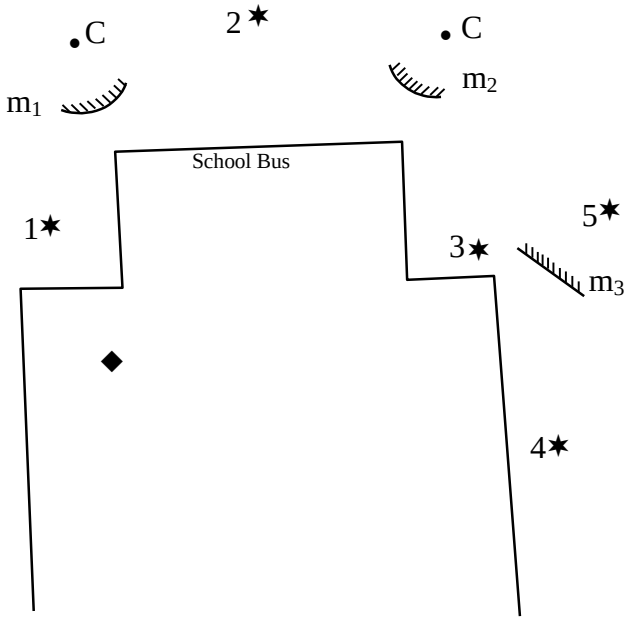
PART B

Questions 16, 17, 18, 19 and 20

If you answer all questions in this section, **draw a line through the question that you do not want to have corrected**. If you do not, questions 16, 17, 18 and 19 will be corrected.

16

SHOW ALL YOUR WORK

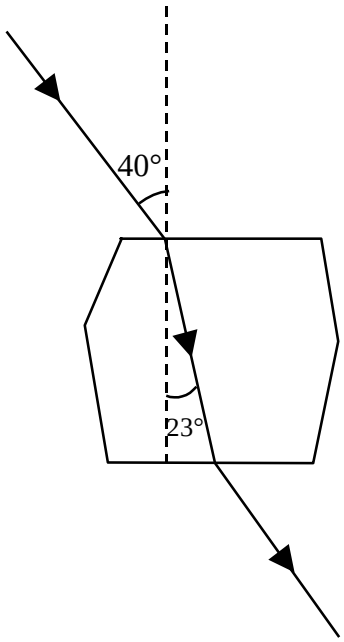


Answer: The bus driver cannot see student(s) _____.

4	3	2	1	0

17

SHOW ALL YOUR WORK



Answer: The gem is made of _____.

4	3	2	1	0

18

EXPLANATION

- Optical power

- Focal length

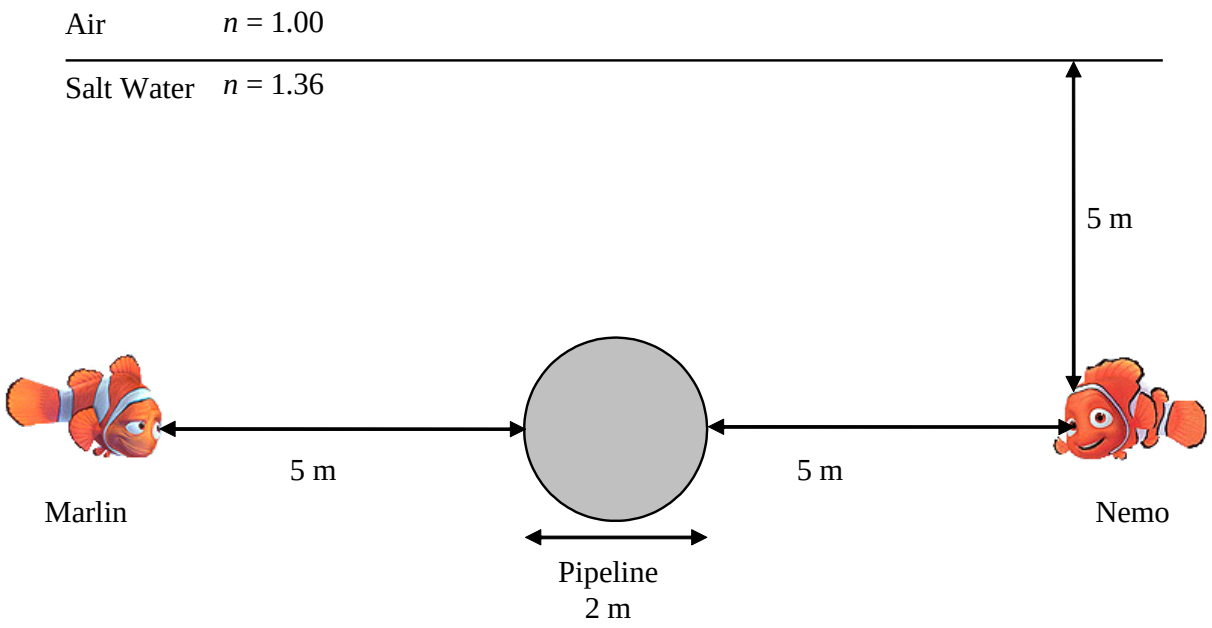
- Magnification

Answer: _____ is right.

4	3	2	1	0

19

SHOW ALL YOUR WORK



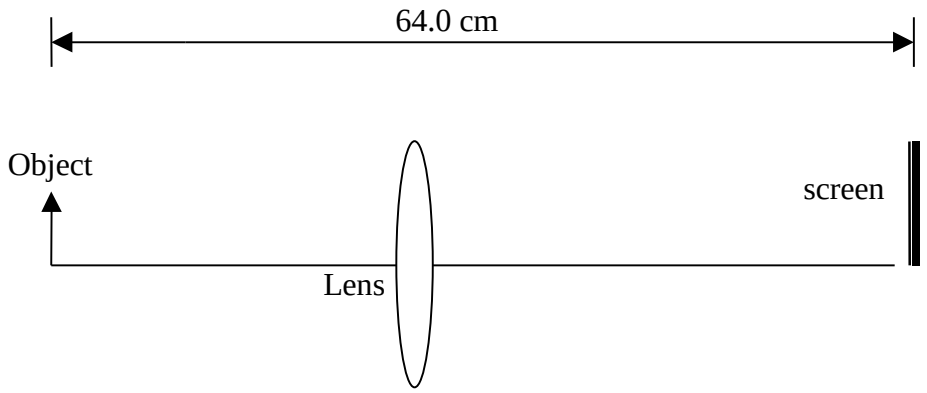
Answer: Marlon and Nemo can see each other because _____

_____.

4	3	2	1	0

20

SHOW ALL YOUR WORK



(You must include correct units.)

Answer: Nadia must place the lens _____ from the object.

4	3	2	1	0

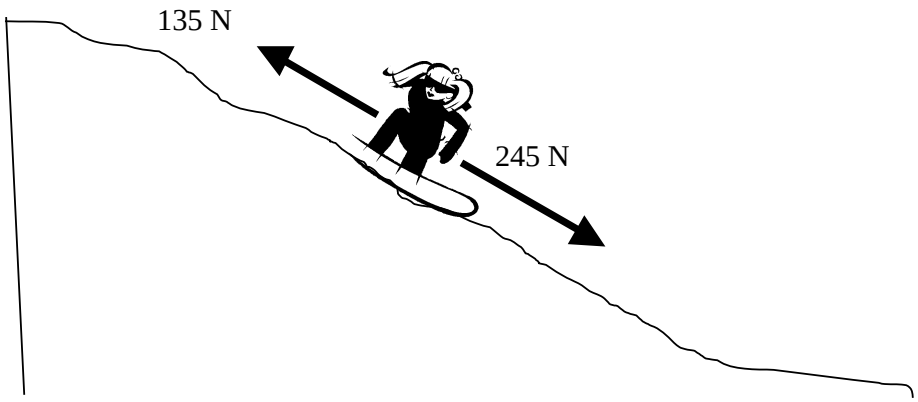
PART C

Questions 21, 22, 23, 24, 25, 26 and 27

If you answer all questions in this section, **draw a line through the question that you do not want to have corrected**. If you do not, questions 21, 22, 23, 24, 25 and 26 will be corrected.

21

SHOW ALL YOUR WORK

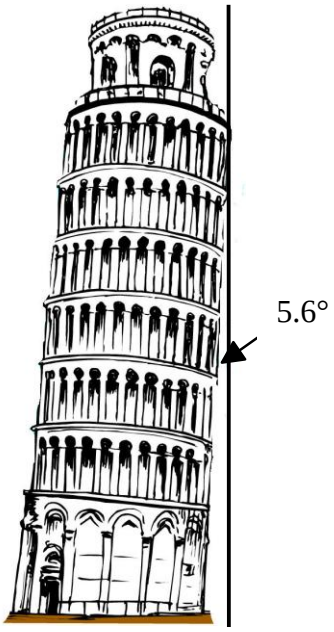


Answer: Kaya's acceleration down the slope is _____.

4	3	2	1	0

22

SHOW ALL YOUR WORK



(You must include correct units.)

Answer: The work done by Galileo on the cannon ball is _____.

4	3	2	1	0

23

SHOW ALL YOUR WORK

(You must include correct units.)

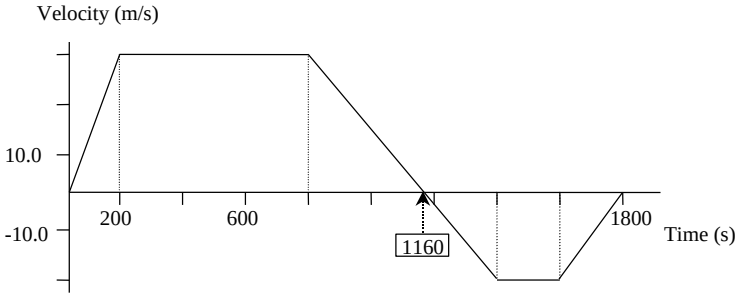
Answer: The speed of the block was _____.

4	3	2	1	0

24

SHOW ALL YOUR WORK

Velocity-time Graph of Ali's Bicycle Race



(You must include correct units.)

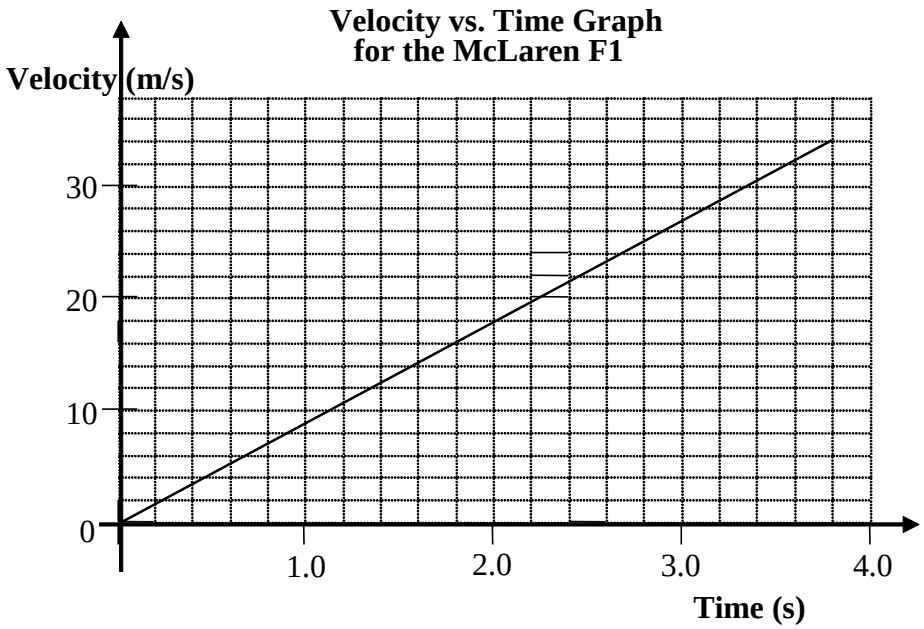
Answer:

1. Ali's acceleration at 400 seconds is _____.
2. Ali's acceleration at 1200 seconds is _____.
3. Ali's displacement between 800 seconds and 1400 seconds is _____.

4	3	2	1	0

25

SHOW ALL YOUR WORK



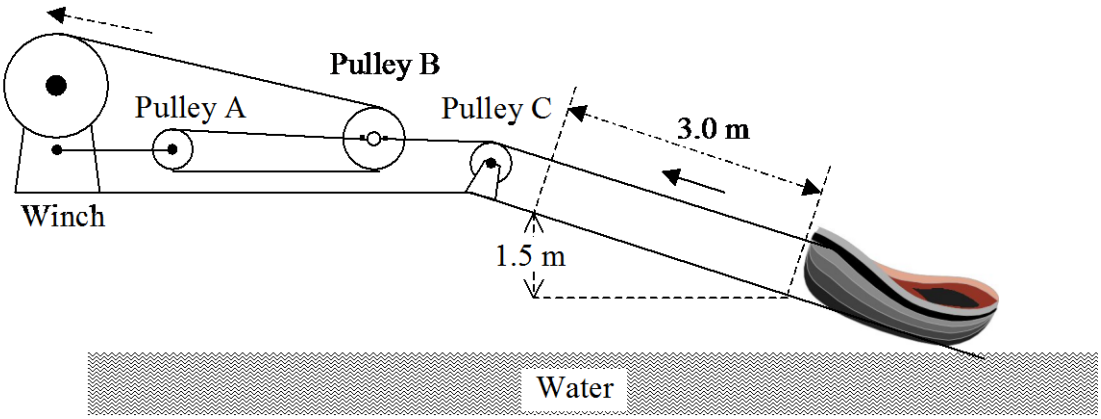
(You must include correct units.)

Answer: The net force required is _____.

4	3	2	1	0

26

SHOW ALL YOUR WORK



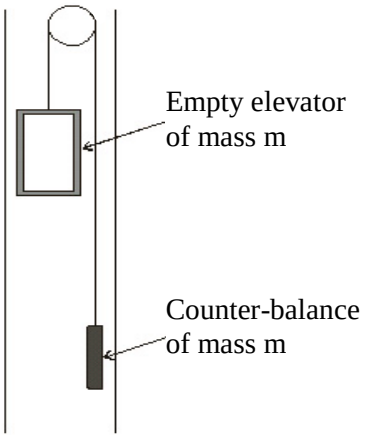
(You must include correct units.)

Answer: The minimum force applied by the winch is _____.

4	3	2	1	0

27

SHOW ALL YOUR WORK



(You must include correct units.)

Answer: The magnitude of the force against which the motor is working is _____.

4	3	2	1	0