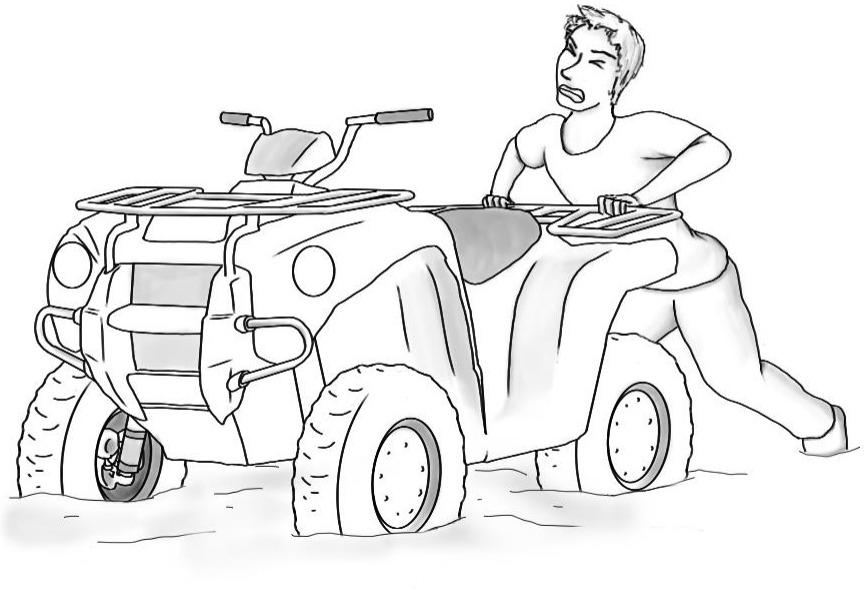
Physics
Theory Examination

June 2014

Physics

Secondary 5



Student Booklet

Instructions

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

2. This examination consists of two parts. Part A: multiple-choice questions and Part B: constructed-response questions.

3. Answer all questions in the ***Answer Booklet***, showing all your work and units.

4. You are permitted to use writing instruments and a calculator with or without graphic display designed mainly to perform mathematical calculations.

   Before the exam starts, data and programs stored in the calculator's memory must be deleted.

   Using a calculator containing stored data or programs will be considered as cheating.

   Students may not share calculators, or communicate between calculators.

   Other electronic devices that have a calculator function are strictly forbidden.

5. You may refer to the information provided in the Appendix of the ***Student Booklet***. The use of any other reference material is strictly forbidden.

6. Hand in the ***Student Booklet*** and the ***Answer Booklet*** at the end of the examination.

Note: *Each question is worth four marks.*
Figures are not necessarily drawn to scale, unless stated.
Significant figures will be evaluated in questions 15 and 24 only.

Time: 3 hours

Part A ***Multiple-Choice Questions***

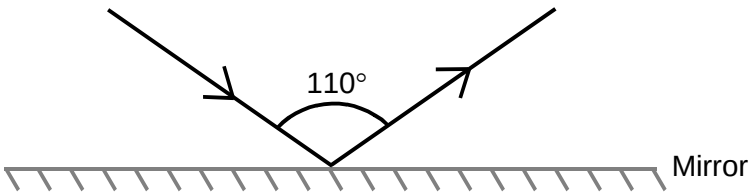
Questions 1 to 10

Answer all questions in the ***Answer Booklet***.

Question 1

The diagram below shows the reflection of a laser beam on a plane mirror.

*Diagram is **not** to scale.*



What is the angle of incidence of the laser beam?

A) 110°

B) 70°

C) 55°

D) 35°

Question 2

An object is placed in front of a lens that is thicker in the middle than at its edges.
The object is placed between the secondary focus and the optical centre.

Which one of the following four choices correctly describes the image produced?

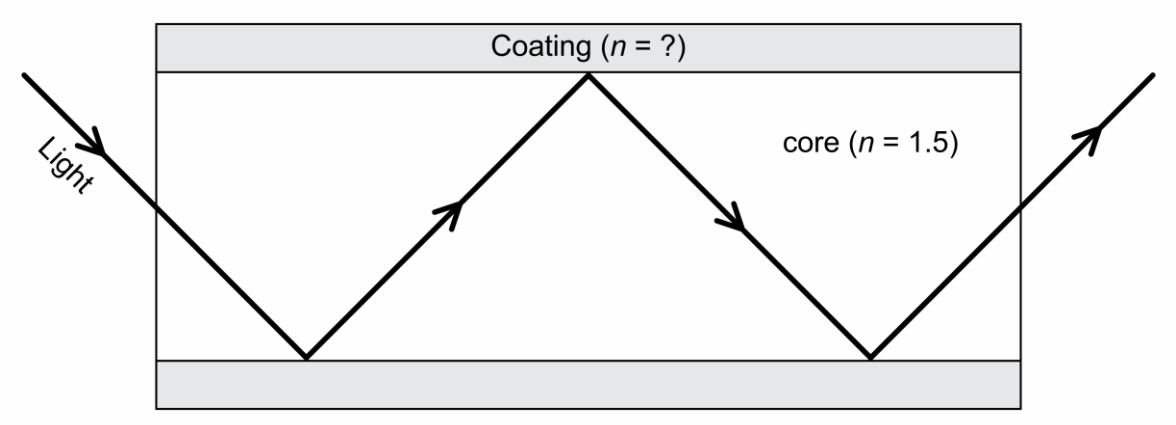
	Image Distance	**Image Attitude**
A)	Positive	Inverted
B)	Positive	Upright
C)	Negative	Inverted
D)	Negative	Upright

Question 3

Glass fibre optic cables use the phenomenon of total internal reflection to keep a light beam within a coated core. This is illustrated in the diagram below.

The core has an index of refraction of 1.5.

Glass Fibre Optic Cable



Which of the following indices of refraction, for the coating, could cause total internal reflection to occur?

A) $n = 0.5$

B) $n = 1.4$

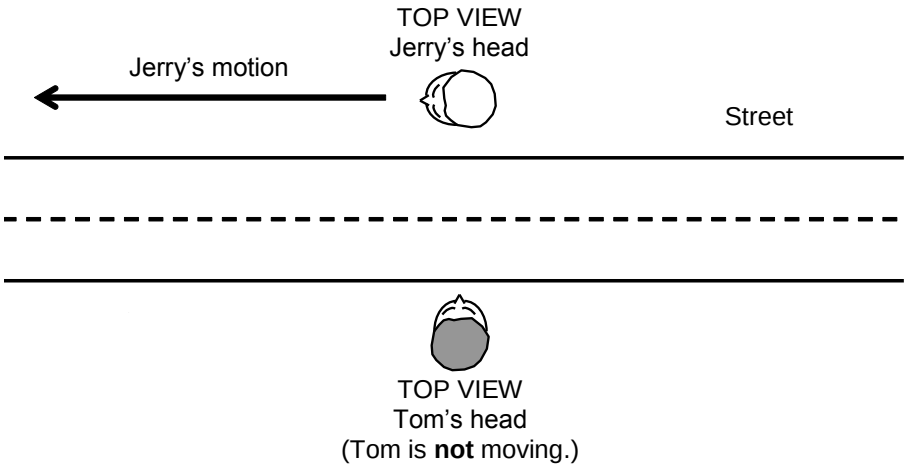
C) $n = 1.5$

D) $n = 1.6$

Question 4

Tom is standing on the sidewalk. He sees his friend Jerry walking on the other side of the street, as illustrated in the diagram below.

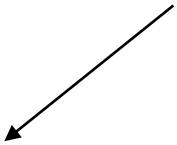
While walking at a constant speed, Jerry drops his cell phone.



Which diagram best describes the trajectory of the cell phone from Tom's point of view?

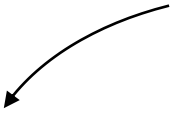
A)

B)



C)

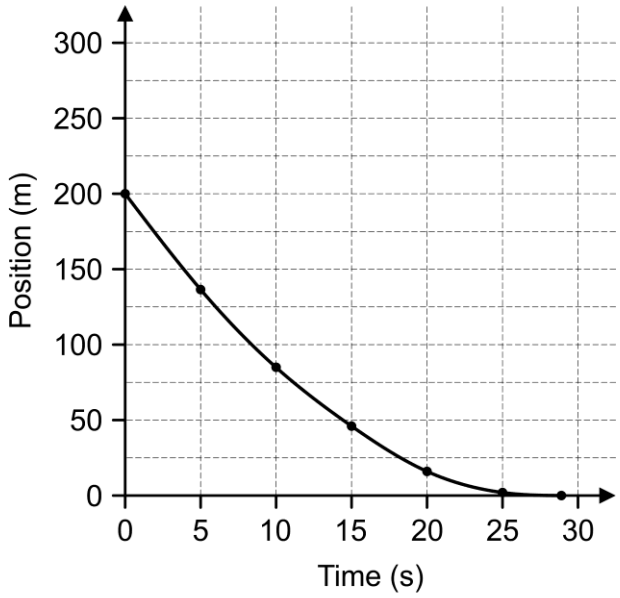
D)



Question 5

A train is slowly coming to a stop. The motion of the train is illustrated by the graph below.

Position versus Time



What is the instantaneous velocity of the train at 12 seconds?

A) 68 m/s

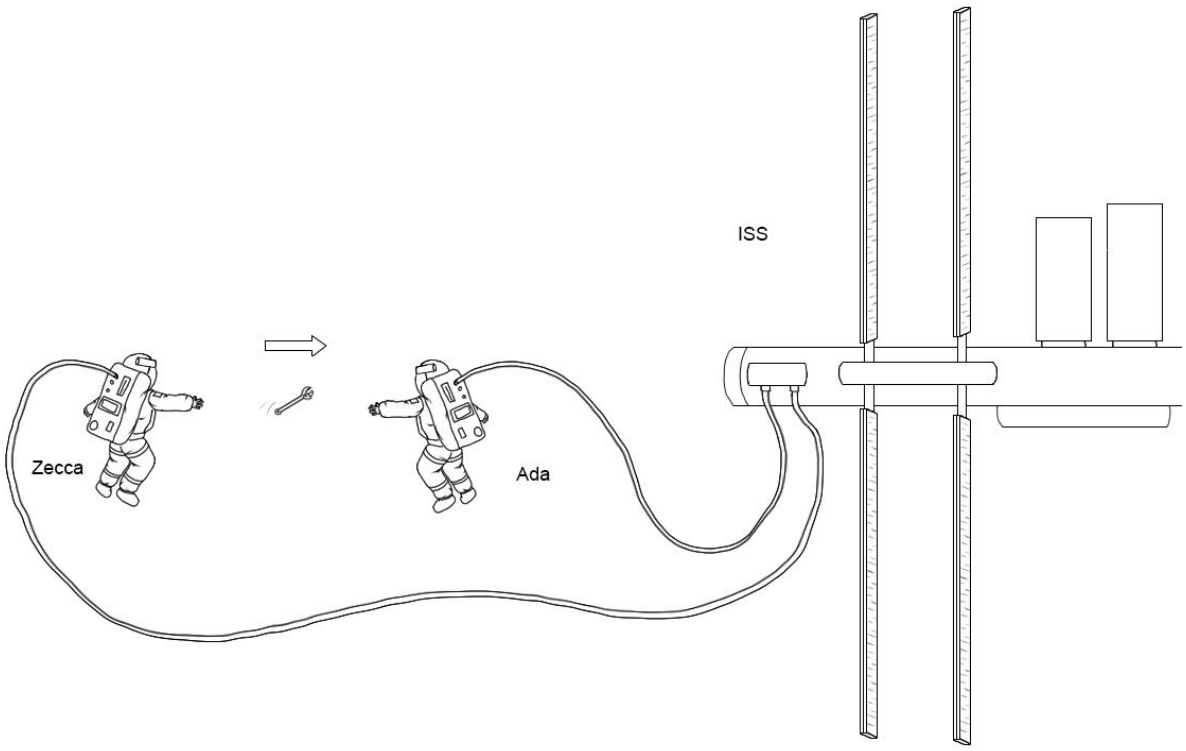
B) 60 m/s

C) – 6.0 m/s

D) – 0.17 km/h

Question 6

Zecca and Ada are astronauts performing maintenance work on the outside of the International Space Station (ISS). Both of them are stationary in relation to the ISS. Ada needs a wrench, so Zecca gently throws it to her and Ada skillfully catches it.



According to Newton's third law of motion, which statement best describes the motion of the astronauts?

A) Zecca will move **away from the ISS** when he throws the wrench, and Ada will move **away from the ISS** when she catches it.

B) Zecca will move **away from the ISS** when he throws the wrench, and Ada will move **towards the ISS** when she catches it.

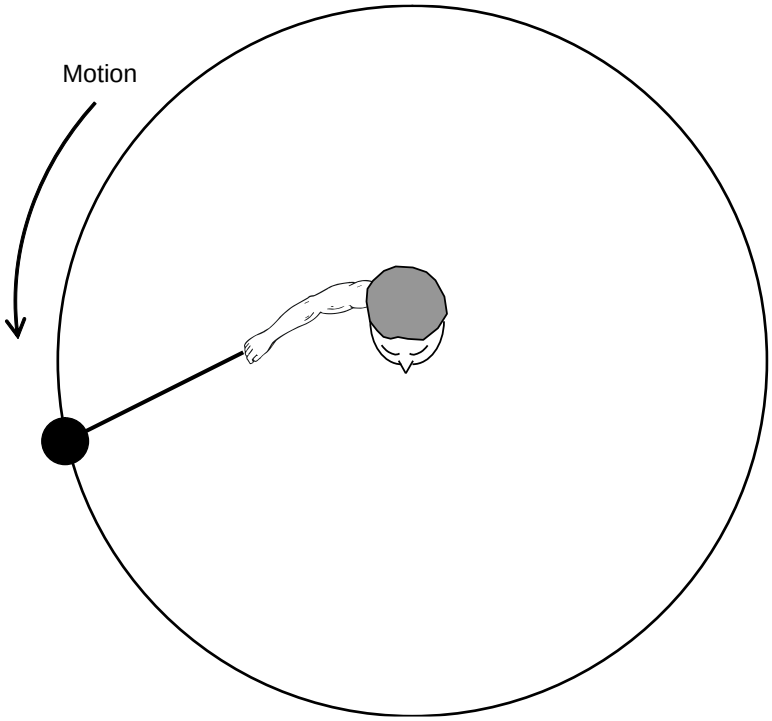
C) Zecca will move **towards the ISS** when he throws the wrench, and Ada will move **away from the ISS** when she catches it.

D) Zecca will move **towards the ISS** when he throws the wrench, and Ada will move **towards the ISS** when she catches it.

Question 7

The hammer throw is a track and field event which involves rotational motion. On the first throw, an athlete rotates his hammer with a velocity of 10 m/s. On his second throw, he plans to double the velocity of the hammer.

Hammer Throw – Top View



What will be the effect of doubling the velocity of the hammer on the centripetal force?

A) The centripetal force will be increased by a factor of two.

B) The centripetal force will be increased by a factor of four.

C) The centripetal force will be decreased by a factor of two.

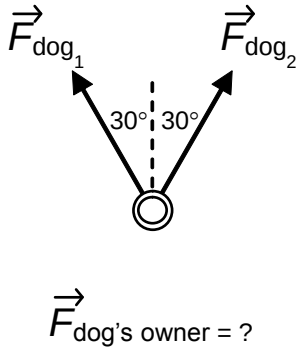
D) The centripetal force will be decreased by a factor of four.

Question 8

Two dogs are pulling on a chew toy, as illustrated in the diagram below. The dog owner also begins pulling on the toy.

Diagram is drawn to scale.

Free-Body Diagram



What force would the dogs' owner have to exert to keep this system in static equilibrium?

A) 

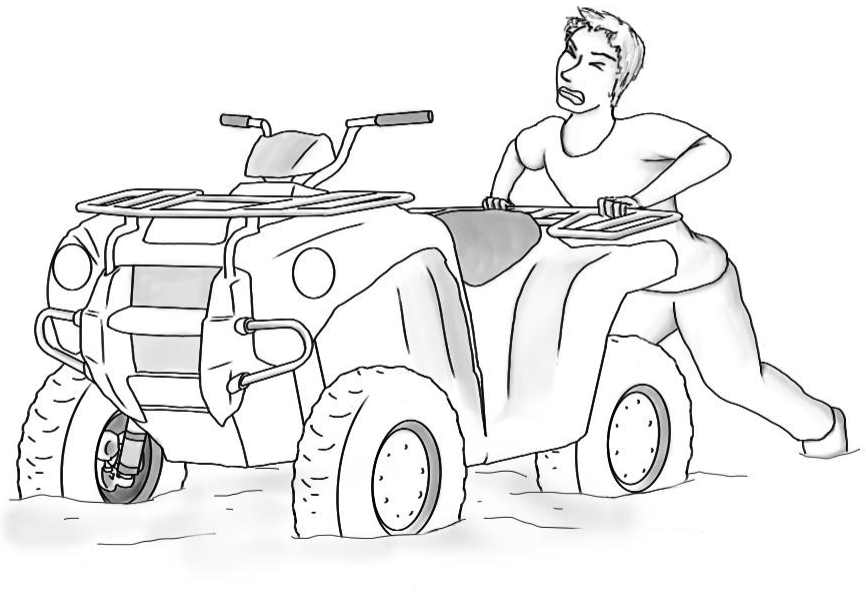
B) 

C) 

D) 

Question 9

Paul's ATV is stuck in the mud. He pushes it with a total force of 800 N and manages to move it a distance of 2 m in 15 s.



What is the power generated by Paul?

A) 24 000 W

B) 1600 W

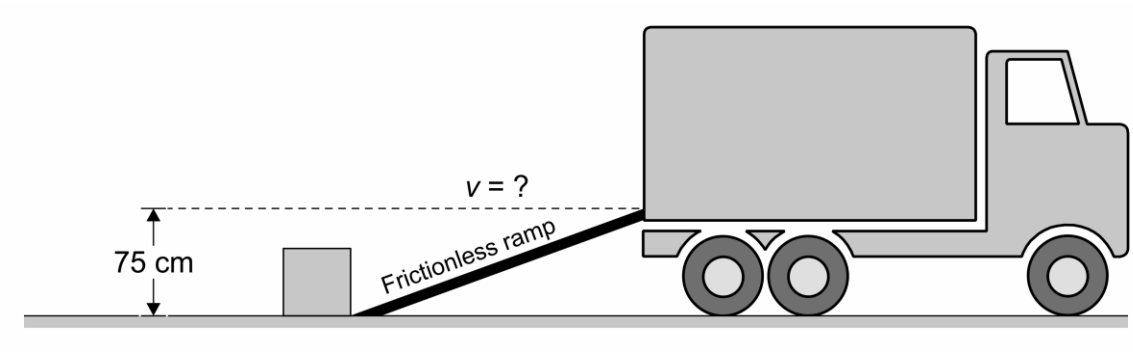
C) 107 W

D) 55 W

Question 10

While loading a truck, Sam and Nic use a frictionless ramp.

They push a 10.0 kg box along the ground at a constant velocity and release the box at the bottom of the ramp. The top of the ramp is 75 cm above the ground.



What minimum velocity must the box have at the bottom of the ramp in order to reach the top of the ramp?

A) 3.8 m/s

B) 15 m/s

C) 38 m/s

D) 1500 m/s

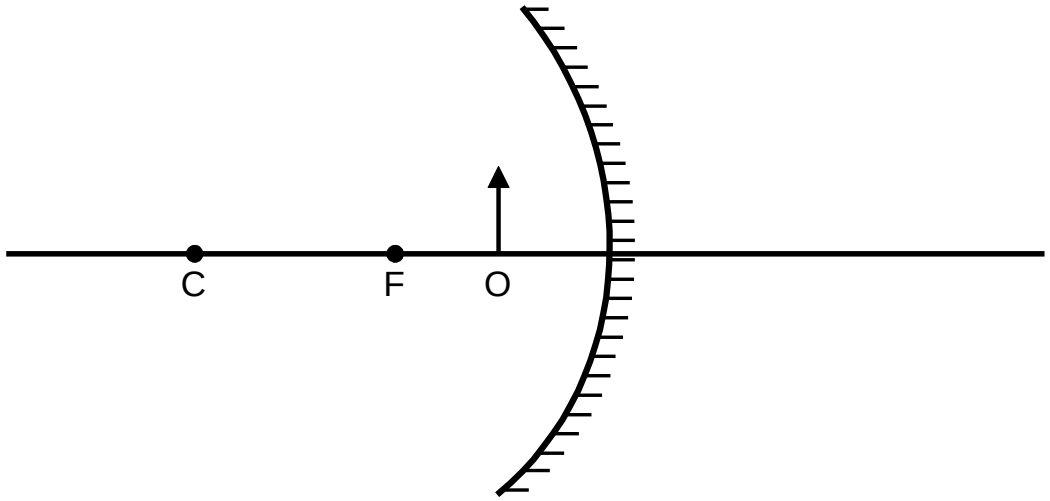
Part B ***Constructed-Response Questions***

Questions 11 to 25

Answer all questions in your ***Answer Booklet***.

Question 11

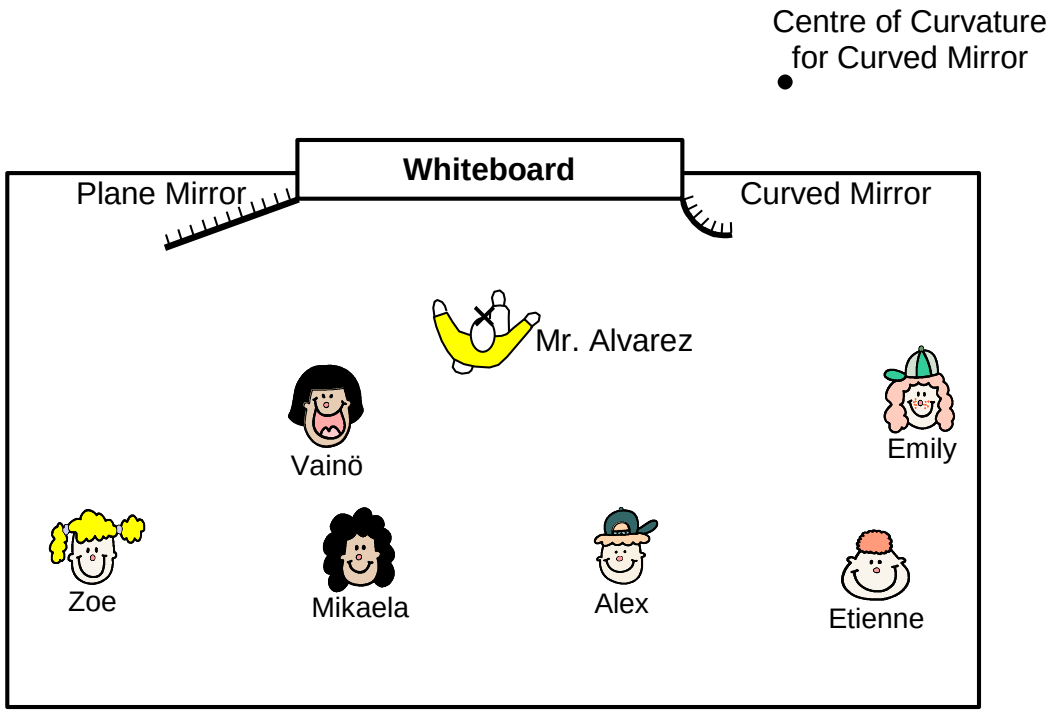
An object (O) is placed in front of a converging mirror as illustrated in the diagram below.



Draw the image formed by the curved mirror.
You must draw a complete ray diagram in your Answer Booklet.

Question 12

Mr. Alvarez has set up a system of two mirrors (one plane and one curved) in his classroom to keep an eye on his misbehaving physics students. Mr. Alvarez's eyes are marked by an x.



Which students are visible in the mirrors from the current position of Mr. Alvarez's eyes?
You must draw a complete ray diagram in your Answer Booklet.

Question 13

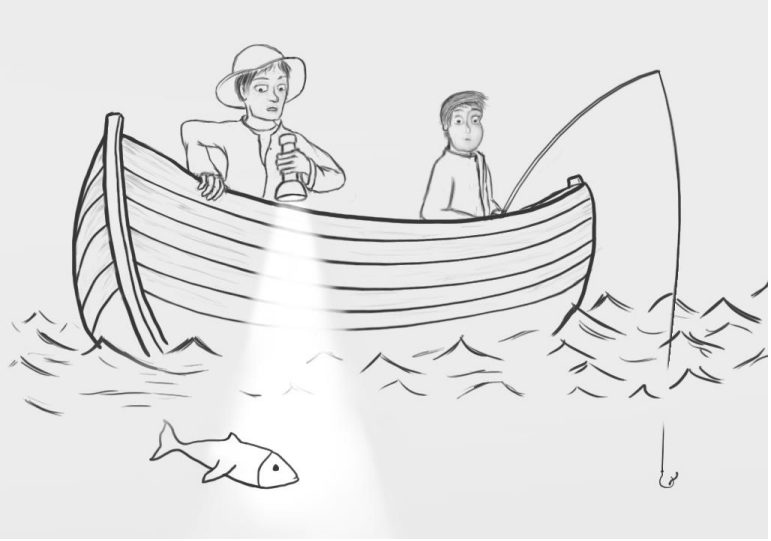
A student observes a microchip through a lens, which has a focal length +15 cm. She notices that the image has the same orientation as the object and is 3 times the size of the object.

What is the distance between the object and the lens?

Question 14

Bob and Doug go night fishing on a lake. They bring along a flashlight and aim it straight down in order to spot a fish in the lake below. It takes 1.153×10^{-8} seconds for the light to reach the fish from the surface of the water.

The index of refraction for water is 1.33.

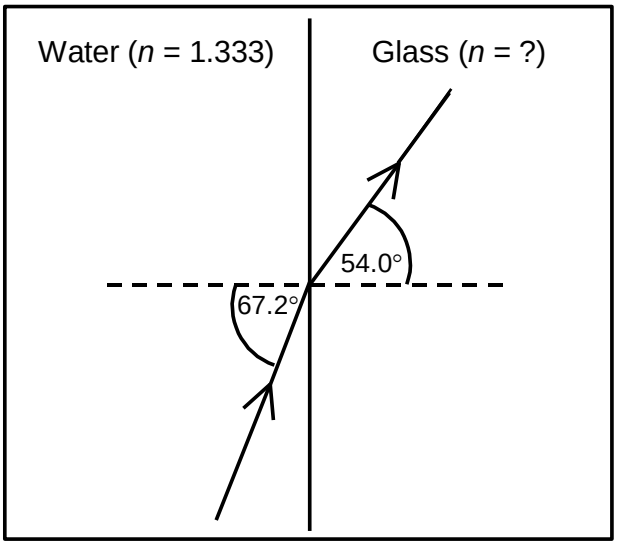


How far below the surface of the water is the fish?

Question 15

A crowd of tourists is watching a diver swim with sharks in a tank of water at an aquarium. The water in the aquarium has an index of refraction of 1.333. Light from the diver's flashlight hits the glass at an angle of 67.2° and then continues inside the glass at an angle of 54.0°.

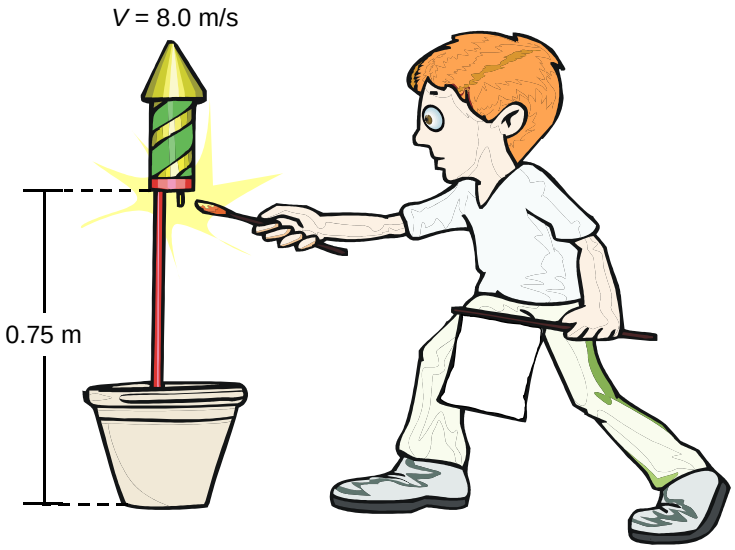
Observe the diagram below.



What is the index of refraction of the glass?
Significant figures will be evaluated in this question.

Question 16

Noah is launching his toy rocket from a height of 0.75 m above the ground. The rocket has an initial velocity of 8.0 m/s, straight up.



What is the velocity of the rocket the instant it hits the ground?

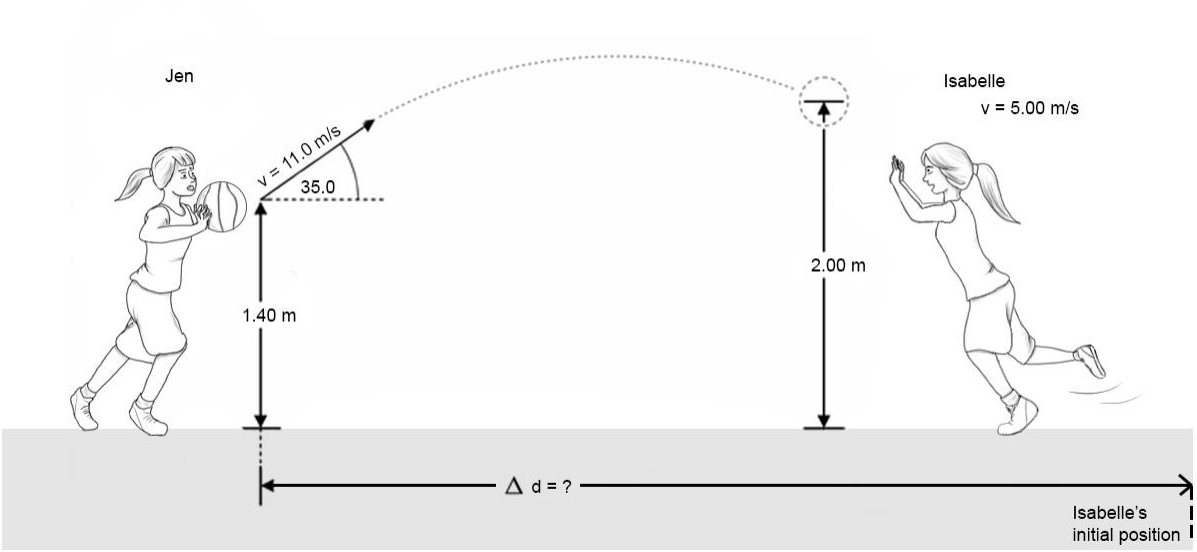
Question 17

Corrine travels on her bicycle at a constant speed of 6 m/s for 50 seconds. She sees a stop sign ahead and decelerates at a constant rate for 45 m until she comes to a complete stop.

Construct a velocity versus time graph of Corrine's bicycle ride.

Question 18

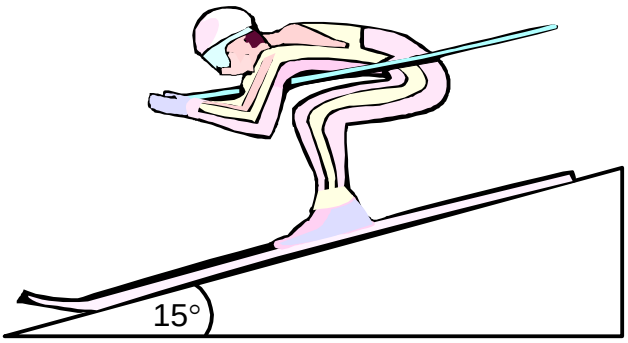
During a basketball practice, Jen throws the ball in the air with an initial velocity of 11.0 m/s, at an angle of 35.0°, and from a height of 1.40 m. At the same moment Isabelle begins running towards the ball with a constant velocity of 5.00 m/s. Isabelle catches the ball on the way down at a height of 2.00 m.



What is the distance between the two players when the ball is thrown?

Question 19

A downhill skier is traveling straight down a hill, which has an incline of 15°.



Draw a complete free-body diagram showing all of the forces acting on the skier.

Question 20

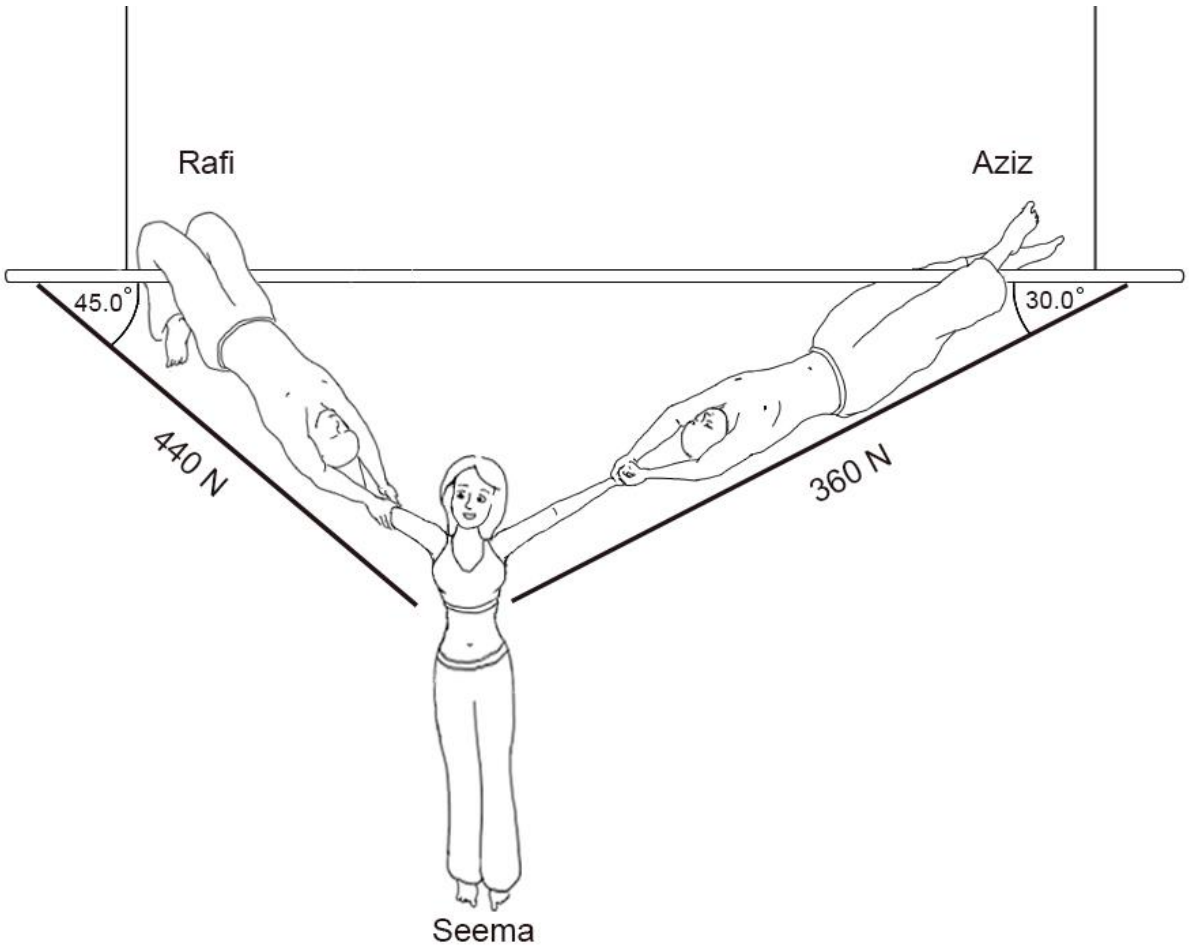
A rover is working to repair part of its equipment on the surface of Mars. The rover drops a tool that has a mass of 0.1 kg. It takes 0.97 seconds for the tool to fall 1.75 m.

What is the weight of the tool on Mars?

Question 21

Seema, Aziz, and Rafi are acrobats for a local circus. Aziz and Rafi hold Seema in the air while they are suspended by a horizontal bar.

In order to hold Seema, Rafi experiences a tension of 440 N at 45.0° and Aziz experiences a tension of 360 N at 30.0°.

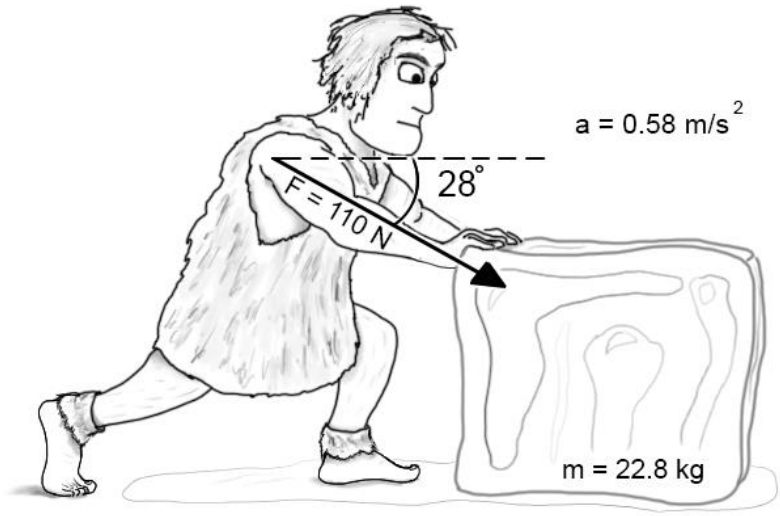


What is Seema's mass?

Question 22

Ötzi is a pre-historic human who is searching for blocks of ice to build his shelter. He finds a 22.8 kg block of ice and pushes it across a flat frozen lake back to his village.

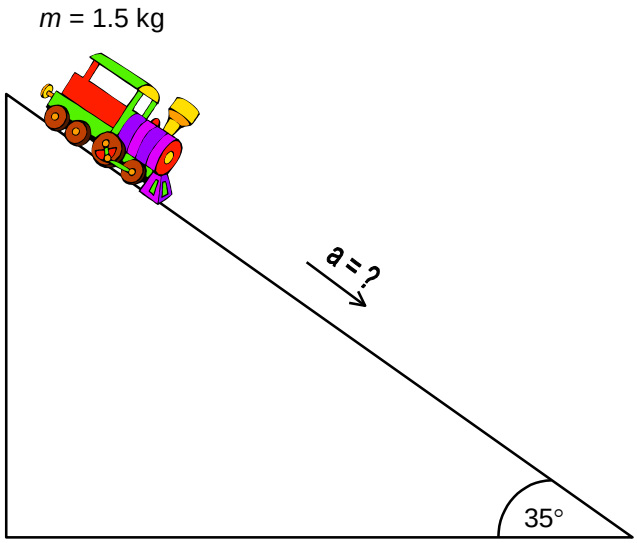
He applies a force of 110 N at an angle of 28° to the horizontal. The block begins to accelerate slowly at a rate of 0.58 m/s^2.



What is the magnitude of the frictional force between the block of ice and the frozen lake?

Question 23

Poloma places a toy train at the top of a ramp with an inclination of 35°. She releases it from rest and it begins to accelerate down the ramp. The mass of the train is 1.5 kg and the force of friction between the train wheels and the ramp is 2.6 N.



What is the acceleration of the train down the ramp?

Question 24

Two teams of physics students are measuring the elastic potential energy stored in springs. They are using two different measuring devices.

Team 1 is using a spring with a spring constant of 4.00×10^2 N/m. The spring has a measured deformation of 0.092 m.

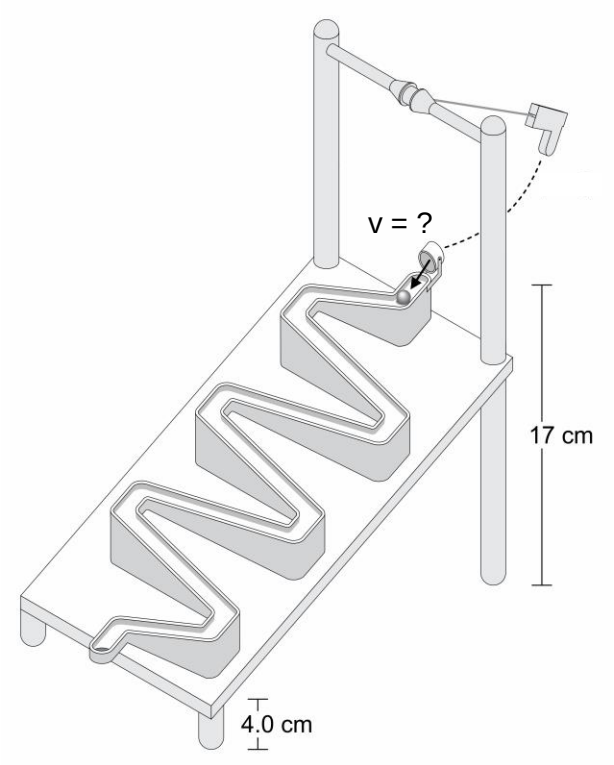
Team 2 is using a spring with a spring constant of 6.000×10^2 N/m. The spring has a measured deformation of 0.062 m.

What is the elastic potential energy stored in each spring?
Significant figures will be evaluated in this question.

Question 25

During a board game called Rat Trap®, mechanical contraptions are activated in a sequence of events. During the sequence illustrated below, a 50.0 g marble is hit by a lever and travels down a zig-zag ramp.

The marble loses 2.0 J of energy due to resistance forces. It arrives at the bottom of the ramp at a speed of 13 m/s. The top of the ramp is 17 cm above the ground and the bottom is 4.0 cm above the ground.



What is the speed of the marble once it has been hit by the lever?

Appendix

Formulas and Quantities

EQUATIONS

OPTICS

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

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

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

$n = \frac{c}{v}$

MECHANICS

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

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

$\Delta d = \left(\frac{v_1 + v_2}{2}\right)\Delta t$

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

$v_2 = v_1 + a\Delta t$

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

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

$W = F\Delta d$

$E_g = mgh$

$E_k = \frac{1}{2}mv^2$

$E_e = \frac{1}{2}k(x)^2$

$F = ma$

$F_g = mg$

$F_e = k\Delta x$

$F_c = \frac{mv^2}{r}$

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
g	Gravitational field strength (Earth)	9.8 N/kg

Physics
Theory Examination

June 2014

PHYSICS

Secondary 5

Answer Booklet

Name: _____ Date: _____ Group: _____

Part A:	____ / 40
Part B:	____ / 60
Total:	____ /100

Time: 3 hours

Part A ***Multiple-Choice Questions***

Questions 1 to 10

Shade the letter that corresponds to your answer.

Each question is worth 4 marks.

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

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

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

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

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

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

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

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

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

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

/40

Part B *Constructed-Response Questions*

Questions 11 to 25

Show all the work needed to solve the problem:
data given, formulas and calculations.

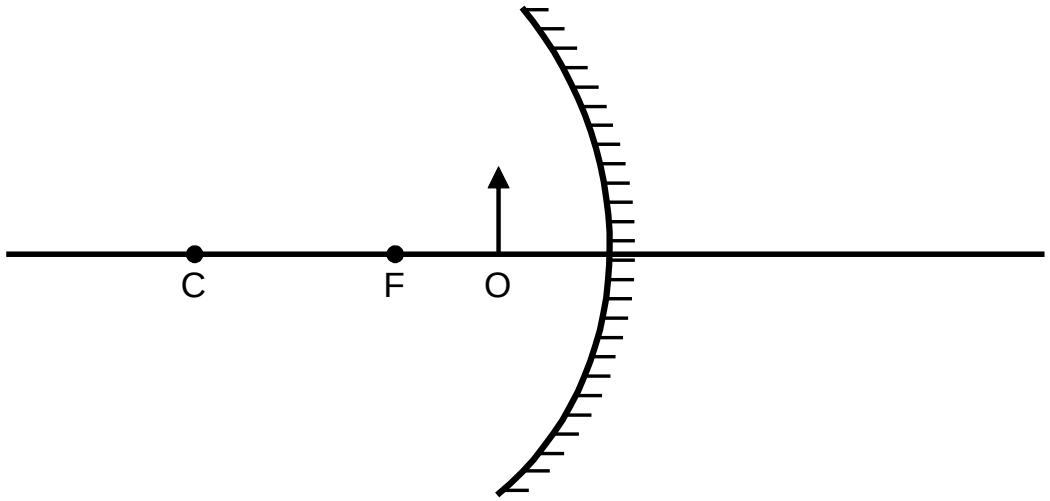
Write your answers using the correct units in the space provided.

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.

Significant figures will be evaluated in questions 15 and 24 only.

Question 11

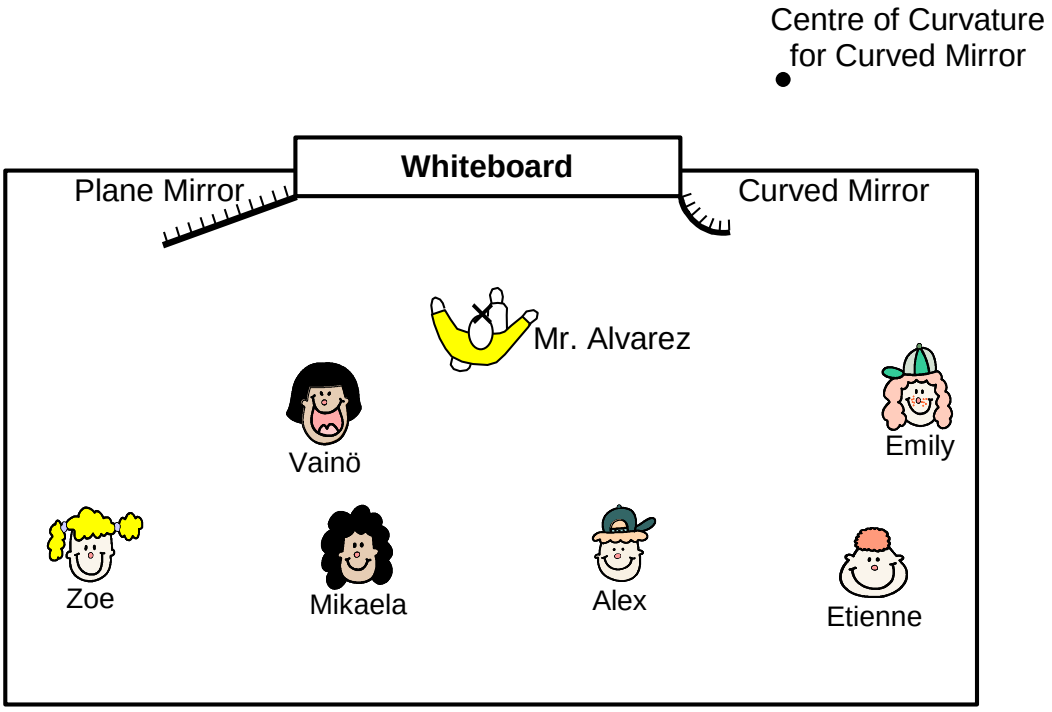
Draw the image formed by the curved mirror.
You must draw a complete ray diagram.



4	3	2	1	0

Question 12

Which students are visible in the mirrors from the current position of Mr. Alvarez's eyes?
You must draw a complete ray diagram.



Answer

The following students are visible in the mirrors:

4	3	2	1	0

Question 13

What is the distance between the object and the lens?

Show all your work.

Answer

The distance between the object and the lens is _____.

4	3	2	1	0

Question 14

How far below the surface of the water is the fish?

Show all your work.

Answer

The fish is _____ below the surface of water.

4	3	2	1	0

Question 15

What is the index of refraction of the glass?
Significant figures will be evaluated in this question.

Show all your work.

Answer

The index of refraction of the glass is _____.

4	3	2	1	0

Question 16

WHAT IS THE VELOCITY OF THE ROCKET THE INSTANT IT HITS THE GROUND?

Show all your work.

Answer

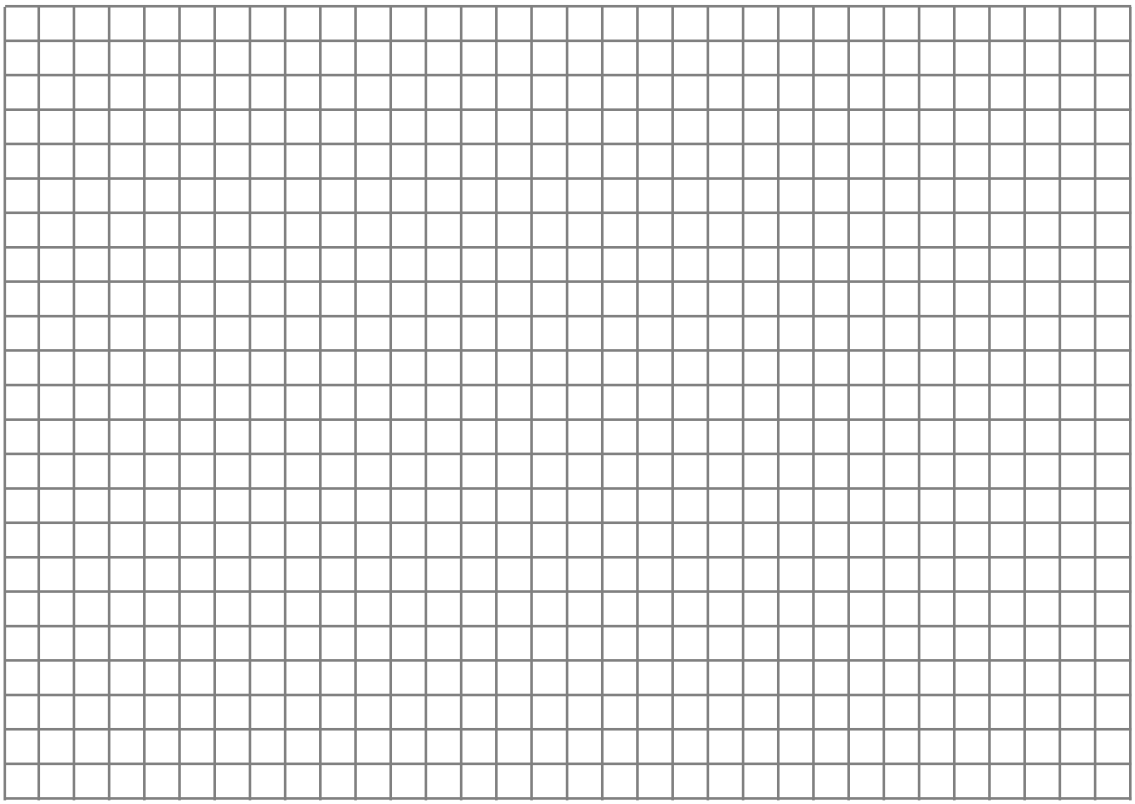
The velocity of the rocket the instant it hits the ground is _____.

4	3	2	1	0

Question 17

Construct a velocity versus time graph of Corrine's bicycle ride.

Show all your work.



4	3	2	1	0

Question 18

What is the distance between the two players when the ball is thrown?

Show all your work.

Answer

The distance between the two players when the ball is thrown is _____.

4	3	2	1	0

Question 19

Draw a complete free body diagram showing all of the forces acting on the skier.

Show all your work.

4	3	2	1	0

Question 20

What is the weight of the tool on Mars?

Show all your work.

Answer

The weight of the tool on Mars is _____.

4	3	2	1	0

Question 21

What is Seema's mass?

Show all your work.

Answer

Seema's mass is_____.

4	3	2	1	0

Question 22

What is the magnitude of the frictional force between the block of ice and the frozen lake?

Show all your work.

Answer

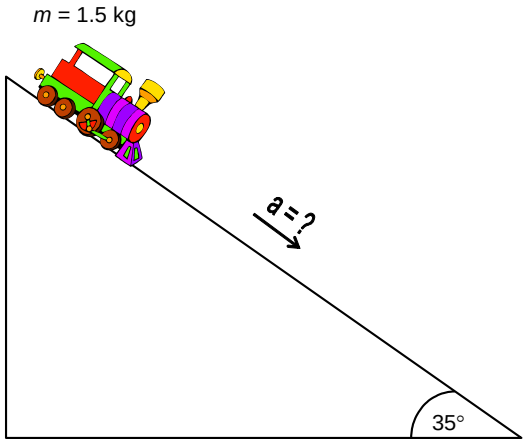
The magnitude of the frictional force is _____.

4	3	2	1	0

Question 23

What is the acceleration of the train down the ramp?

Show all your work.



Answer

The acceleration of the train down the ramp is _____.

4	3	2	1	0

Question 24

What is the elastic potential energy stored in each spring?

Significant figures will be evaluated in this question.

Show all your work.

Answer

Team 1's spring has a stored elastic potential energy of _____.

Team 2's spring has a stored elastic potential energy of _____.

4	3	2	1	0

Question 25

WHAT IS THE SPEED OF THE MARBLE ONCE IT HAS BEEN HIT BY THE LEVER?

Show all your work.

Answer

The speed of the marble once it has been hit by the lever is _____.

4	3	2	1	0

Marking Guide

Part A ***Multiple-Choice Questions***
Questions 1 to 10

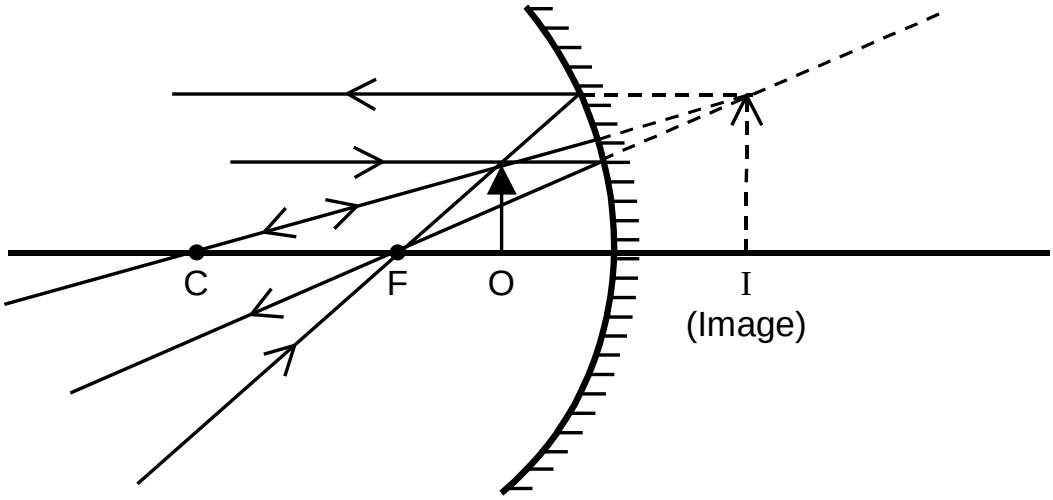
Question 1	C	4 0
Question 2	D	4 0
Question 3	B	4 0
Question 4	D	4 0
Question 5	C	4 0
Question 6	B	4 0
Question 7	B	4 0
Question 8	B	4 0
Question 9	C	4 0
Question 10	A	4 0

Part B *Constructed-Response Questions*
Questions 11 to 25

NOTE:
- **The following examples of appropriate responses are guidelines and are not exhaustive. Teachers should use their professional judgement when correcting this exam.**
- **Significant figures will be evaluated in questions 15 and 24 only.**

Question 11

Example of an appropriate diagram



Note: Only 2 of 3 rays are required for full marks.

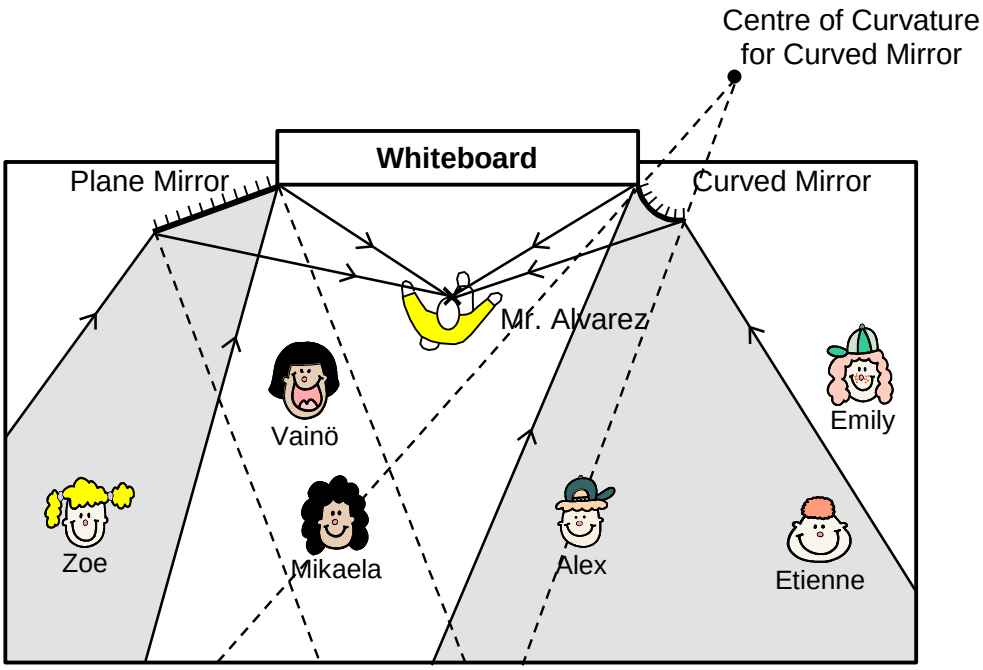
Marking Scale[1]

4 marks	Appropriate diagram and correct position and size of image
3 marks	Appropriate diagram, but incorrect answer due to a minor error such as no direction indicated on rays
2 marks	Appropriate diagram, but incorrect answer due to a major error (e.g. student draws 2 correctly reflected rays, but does not draw the image)
1 mark	Partially appropriate diagram (e.g. student draws at least one ray properly)
0 marks	Inappropriate diagram, or did not provide a diagram, regardless of the answer

1. All Marking Scales adapted from *MELS, 555-410, Science and Technology, Marking Guide, June 2012*.

Question 12

Examples of an appropriate response



Answer

The following students are visible in the mirrors: **Zoe, Alex and Etienne**.

Marking Scale

4 marks	Appropriate diagram and correct answers. Note: angles may be off by a small amount
3 marks	Appropriate diagram, but incorrect answer due to a minor error such as student does not show proper direction on the rays, or angles/normals are inaccurate i.e. student may or may not have correct final answer
2 marks	Appropriate diagram, but incorrect answer due to a major error such as not identifying the field of vision (e.g. identifies Vainö and Mikaela as visible because they are between the two normals, or the student draws a completely correct diagram but states that all students are visible except for Emily
1 mark	Partially appropriate procedure (e.g. only draws rays for one mirror)
0 marks	No diagram is drawn, or a diagram with many mistakes is drawn

Question 13

Example of an appropriate procedure

Given variables:

$M = 3$

$f = +15 \text{ cm}$

$d_i = ?$

$d_o = ?$

1. Find distance of object:

$$3 = \frac{-d_i}{d_o}$$

$$-3d_o = d_i$$

$$\frac{1}{15 \text{ cm}} = \frac{1}{d_o} + \frac{1}{-3d_o}$$

$$\frac{1}{15 \text{ cm}} = -\frac{1}{3d_o} + \frac{3}{3d_o}$$

$$\frac{1}{15 \text{ cm}} = \frac{2}{3d_o}$$

$$3\,d_o = 30 \text{ cm}$$

$$d_o = 10 \text{ cm}$$

Answer

The distance between the object and the lens is **10 cm**.

Marking Scale

4 marks	Appropriate procedure and correct answer
3 marks	Appropriate procedure, but incorrect answer due to a minor error, such as a calculation or transcription error, or missing unit of measure
2 marks	Appropriate procedure, but incorrect answer due to a major error such as the incorrect application of a law, formula or rule (e.g. the student correctly substitutes but fails to solve for d_o)
1 mark	Partially appropriate procedure (e.g. the student completes the magnification equation and focal distance equation with the knowns and unknowns, but fails to solve)
0 marks	Inappropriate procedure, or did not provide a procedure, regardless of the answer

Question 14

Example of an appropriate procedure

Given variables:

$$n_{\text{water}} = 1.33$$
$$\Delta t = 1.153 \times 10^{-8} \text{ seconds}$$
$$\Delta d = ?$$
$$c = 3.00 \times 10^{8} \text{ m/s}$$

1. Find speed of light in water:

$$n_{\text{water}} = \frac{c}{v_{\text{water}}}$$
$$v_{\text{water}} = \frac{c}{n_{\text{water}}} = \frac{3.00 \times 10^{8} \text{m/s}}{1.33} = 2.25563 \times 10^{8} \text{ m/s}$$

2. Find the distance travelled in water:

$$\text{v} = \frac{\Delta \text{d}}{\Delta \text{t}}$$
$$\Delta \text{d} = \text{v}\Delta \text{t} = \left(2.25563 \times 10^{8} \text{ m/s}\right)\left(1.153 \times 10^{-8} \text{ s}\right)$$
$$\Delta \text{d} = 2.6 \text{ m}$$

Note: Significant figures are not taken into consideration in this question.

Answer

The fish is **2.6 m** below the surface of the water.

Marking Scale

4 marks	Appropriate procedure and correct answer
3 marks	Appropriate procedure, but incorrect answer due to a minor error, such as a calculation or transcription error, or missing unit of measure
2 marks	Appropriate procedure, but incorrect answer due to a major error such as the incorrect application of a law, formula or rule (e.g. using speed of light in a vacuum instead of speed of light in water)
1 mark	Partially appropriate procedure (e.g. calculating only the speed of light in water)
0 marks	Inappropriate procedure, or did not provide a procedure, regardless of the answer

Question 15

Example of an appropriate procedure

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$
$$(1.333) \sin 67.2° = n_2 \sin 54.0°$$
$$n_2 = 1.51893$$
$$n_2 = 1.52$$

Note: Significant figures ***are*** taken into consideration in this question.

Answer

The index of refraction of the glass is **1.52** (significant figures).

Marking Scale

4 marks	Appropriate procedure and correct answer
3 marks	Appropriate procedure, but incorrect answer due to a minor error, such as a calculation or transcription error, or missing unit of measure or student did not take significant figures into account
2 marks	Appropriate procedure, but incorrect answer due to a major error such as the incorrect application of a law, formula or rule (e.g. used incorrect angles)
1 mark	Partially appropriate procedure
0 marks	Inappropriate procedure, or did not provide a procedure, regardless of the answer

Question 16

Examples of an appropriate procedure

Given variables:

$v_1 = 8\ \text{m/s}$

$\Delta d = -0.75\ \text{m}$

$a = -9.8\ \text{m/s}^2$

1. Solve for the final velocity:

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

$$v_2 = \sqrt{(8\ \text{m/s})^2 + 2\left(-9.8\ \text{m/s}^2\right)(-0.75\ \text{m})}$$

$$v_2 = \pm 8.87\ \text{m/s}$$

Note: Significant figures are not taken into consideration in this question.

Answer

The velocity of the rocket the instant it hits the ground is **– 8.9 m/s or 8.9 m/s downward**.

Marking Scale

4 marks	Appropriate procedure and correct answer
3 marks	Appropriate procedure, but incorrect answer due to a minor error, such as a calculation or transcription error, or missing unit of measure
2 marks	Appropriate procedure, but incorrect answer due to a major error such as the incorrect application of a law, formula or rule (e.g. did not indicate that the velocity is negative or downward or uses a positive displacement
1 mark	Partially appropriate procedure
0 marks	Inappropriate procedure, or did not provide a procedure, regardless of the answer

Question 17

Example of an appropriate procedure

To calculate the time spent coming to a complete stop (second part of graph showing deceleration).

$$\Delta d = \left[\frac{v_1 + v_2}{2}\right] \Delta t$$

$$45\ \text{m} = \left[\frac{6\ \text{m/s} + 0}{2}\right] \Delta t$$

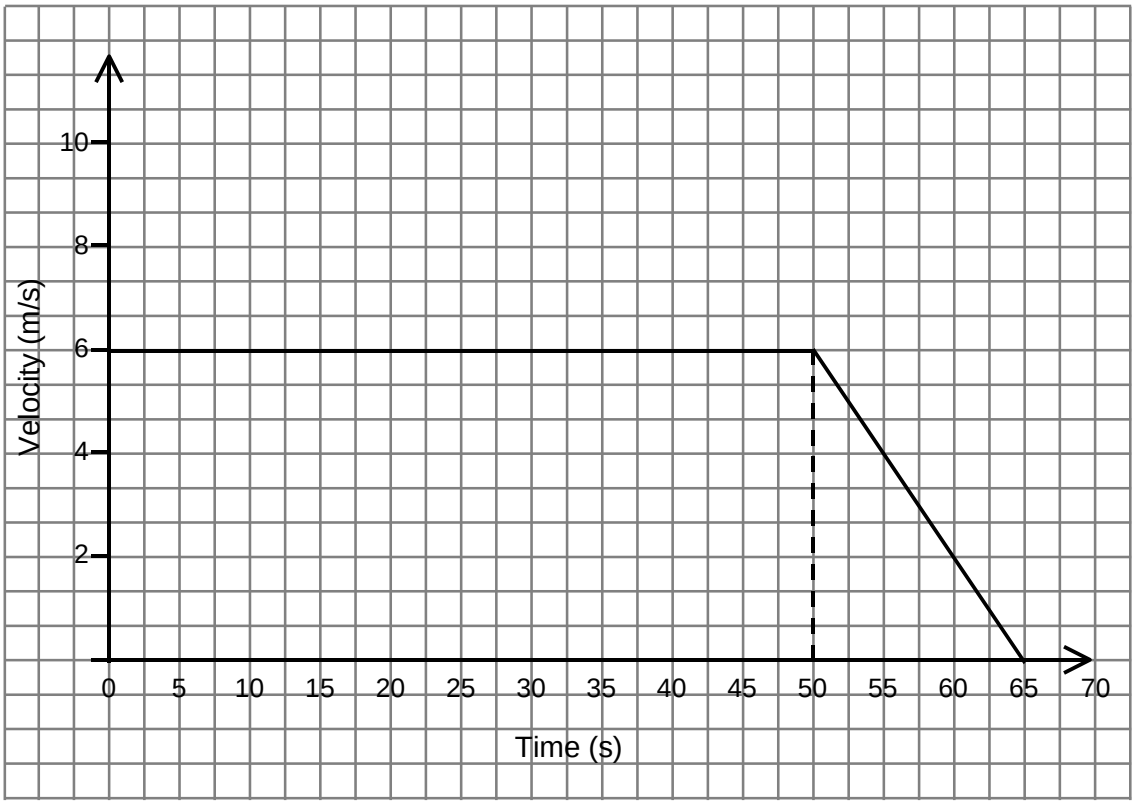
$$45\ \text{m} = 3\ \text{m/s}\ \Delta t$$

$$\Delta t = \frac{45\ \text{m}}{3\ \text{m/s}}$$

$$\Delta t = 15\ \text{s}$$

Note: Significant figures are not taken into consideration in this question.

Velocity versus Time



Question 17 (*Cont'd*)

Marking Scale

4 marks	Appropriate procedure and graph
3 marks	Appropriate procedure, but incorrect answer due to a minor error, such as a calculation or transcription error, or inaccurate graph/calculation where there are missing labels or missing units
2 marks	Appropriate procedure, but incorrect answer due to a major error such as the incorrect application of a law, formula or rule (e.g. student shows all the calculations correctly but fails to represent it correctly on the graph)
1 mark	Partially appropriate procedure (e.g. student only shows the first part of the motion correctly)
0 marks	Inappropriate procedure, or did not provide a procedure, regardless of the answer

Question 18

Examples of an appropriate procedure

1. Find the time it takes for the ball to reach a height of 2 m (on the way down).
   Vertical component of motion:

$$\Delta d = 0.6\ \text{m}$$

$$a = -9.8\ \text{m/s}^2$$

$$v_{iy} = 11\,\text{m/s}\,(\sin 35°)$$

$$v_{iy} = 6.309\ \text{m/s}$$

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

$$0.6\ \text{m} = 6.309\ \text{m/s}\ \Delta t + \frac{1}{2}\left(-9.8\ \text{m/s}^2\right)(\Delta t)^2$$

$$\Delta t = 1.18\ \text{s}$$

2. Find the horizontal distance the ball will travel in 1.18 s.

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

$$\Delta d = 11\,\text{m/s}\,(\cos 35°)(1.18\ \text{s})$$

$$\Delta d = 10.669\ \text{m}$$

3. Calculate how far Isabelle will travel in 1.18 s.

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

$$\Delta d = 5\ \text{m/s}\,(1.18\ \text{s})$$

$$\Delta d = 5.9\ \text{m}$$

4. Distance between the two players:
   10.669 m + 5.90 m = 16.569 m

Note: Significant figures are not taken into consideration in this question.

Answer

The distance between the two players when the ball is thrown is **16.6 m**.

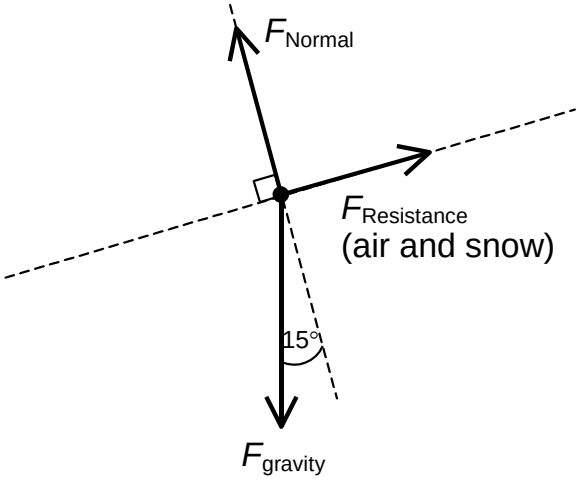
Marking Scale	
4 marks	Appropriate procedure and correct answer
3 marks	Appropriate procedure, but incorrect answer due to a minor error, such as a calculation or transcription error, or missing unit of measure (e.g. student only solves for the ball's horizontal displacement)
2 marks	Appropriate procedure, but incorrect answer due to a major error such as the incorrect application of a law, formula or rule (e.g. student only solves for time)
1 mark	Partially appropriate procedure (e.g. student solves for the horizontal and vertical components of the initial velocity)

0 marks	Inappropriate procedure, or did not provide a procedure, regardless of the answer

Question 19

Example of an appropriate response

Free-Body Diagram



Also, accept a rotated view where the F_{Normal} is straight up (vertical) and $F_{Resistance}$ is horizontal.

Note: Students should not be penalized for the relative lengths of the vectors. Students may indicate $F_{Resistance}$ using 2 vectors (air and snow). Students should include the 15° angle or the 75° (90° – 15°) angle.

Marking Scale

4 marks	Appropriate diagram with all four components properly identified and labelled, i.e. 3 force vectors and the angle
3 marks	Appropriate diagram with three out of four components properly identified and labelled
2 marks	Appropriate diagram with two components properly identified and labelled
1 mark	Partially appropriate diagram with at least one component identified and labelled
0 marks	Inappropriate diagram, or did not provide a diagram, regardless of the answer

Question 20

Example of an appropriate procedure

Given variables:

$v_1 = 0\ \text{m/s}$

$\Delta t = 0.97\ \text{s}$

$\Delta d = -1.75\ \text{m}$

$a = ?$

$m = 0.1\ \text{kg}$

1. Find acceleration due to gravity on Mars:

$\Delta d = v_1 \Delta t + ½\, a \Delta t^2$

$\Delta d = ½\, a \Delta t^2$

$$a = \frac{2\Delta d}{\Delta t^2} = \frac{2\left(-1.75\ \text{m}\right)}{\left(0.97\ \text{s}\right)^2}$$

$a = -3.72\ \text{m/s}^2$

2. Find the weight of the tool on Mars:
If $a = -3.72\ \text{m/s}^2$, then $g = 3.72\ \text{N/kg}$

$F_g = mg$

$F_g = 0.1\,\text{kg}\left(3.72\ \text{N/kg}\right)$

$F_g = 0.37\ \text{N}$

Note: Significant figures are not taken into consideration in this question.

Answer

The weight of the tool on Mars is **0.37 N**.

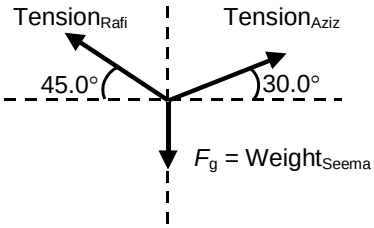
Marking Scale

4 marks	Appropriate procedure and correct answer
3 marks	Appropriate procedure, but incorrect answer due to a minor error, such as a calculation or transcription error, or missing unit of measure
2 marks	Appropriate procedure, but incorrect answer due to a major error such as the incorrect application of a law, formula or rule (e.g. student only solves for the acceleration due to gravity on Mars)
1 mark	Partially appropriate procedure (e.g. student finds the weight of the tool on Earth)
0 marks	Inappropriate procedure, or did not provide a procedure, regardless of the answer

Question 21

Example of an appropriate procedure

Free-Body Diagram



1. Find the vertical components of the force vectors.

   $F_{r(y)} = T_{Rafi} \sin 45° + T_{Aziz} \sin 30° - F_g = 0$ since the situation is in static equilibrium.

$$F_{r(y)} = 440\,\text{N} \sin 45 + 360\,\text{N} \sin 30 - F_g = 0$$
$$F_{r(y)} = 311\,\text{N} + 180\,\text{N} - F_g = 0$$
$$F_g = 491\,\text{N}$$

2. Find Seema's mass:

$$F_g = mg$$
$$491\,\text{N} = m\,(9.8\,\text{N/kg})$$
$$m = \frac{491\,\text{N}}{9.8\,\text{N/kg}}$$
$$m = 50.1\,\text{kg}$$

Answer

Seema's mass is **50.1 kg or 50 kg**.

Note: Significant figures are not taken into consideration in this question.

Marking Scale

4 marks	Appropriate procedure and correct answer
3 marks	Appropriate procedure, but incorrect answer due to a minor error, such as a calculation or transcription error, or missing unit of measure
2 marks	Appropriate procedure, but incorrect answer due to a major error such as the incorrect application of a law, formula or rule (e.g. found Seema's weight but not her mass)
1 mark	Partially appropriate procedure
0 marks	Inappropriate procedure, or did not provide a procedure, regardless of the answer

Question 22

Example of an appropriate procedure

1. Find *x* component of applied force

$$F_{\text{applied}} = 110\ \text{N} \cos 28°$$

$$F_{\text{applied}} = 97\ \text{N}$$

2. Find F_{net} for block of ice

$$F_{\text{net}} = ma$$

$$F_{\text{net}} = (22.8\ \text{kg})(0.58\ \text{m/s}^2)$$

$$F_{\text{net}} = 13.224\ \text{N}$$

$$F_{\text{net}} = 13\ \text{N}$$

3. Find F_{f}

$$F_{\text{net}} = F_{\text{applied}} + F_{\text{f}}$$

$$F_{\text{f}} = F_{\text{applied}} - F_{\text{net}}$$

$$F_{\text{f}} = 13\ \text{N} - 97\ \text{N}$$

$$F_{\text{f}} = -84\ \text{N}$$

Note: Significant figures are not taken into consideration in this question.

Answer

The magnitude of the frictional force is **84 N**.

Marking Scale

4 marks	Appropriate procedure and correct answer
3 marks	Appropriate procedure, but incorrect answer due to a minor error, such as a calculation or transcription error, or missing unit of measure
2 marks	Appropriate procedure, but incorrect answer due to a major error such as the incorrect application of a law, formula or rule (e.g. not taking the angle into account)
1 mark	Partially appropriate procedure (e.g. only solving for net force)
0 marks	Inappropriate procedure, or did not provide a procedure, regardless of the answer

Question 23

Example of an appropriate procedure

Given variables:

$m = 1.5\ \text{kg}$

$\vec{F}_f = -2.6\ \text{N}$

1. Find Fg parallel to incline:

$F_g = mg$

$F_g = (1.5\ \text{kg})(9.8\ \text{N/kg})$

$F_g = 14.7\ \text{N}$

$F_{g_{parallel}} = F_g \sin\theta$

$F_{g_{parallel}} = (14.7\ \text{N}) \sin 35°$

$F_{g_{parallel}} = 8.43\ \text{N}$

2. Find acceleration:

$\vec{F}_{net} = \vec{F}_{g_{parallel}} + \vec{F}_f$

$\vec{F}_{net} = (8.43\ \text{N}) + (-2.6\ \text{N})$

$\vec{F}_{net} = 5.83\ \text{N}$

$a = \dfrac{\vec{F}_{net}}{m}$

$a = \dfrac{5.83\ \text{N}}{1.5\ \text{kg}}$

$a = 3.89\ \text{m/s}^2$

Note: Significant figures are not taken into consideration in this question.

Answer

The acceleration of the train down the ramp is **3.9 m/s²**.

Marking Scale

4 marks	Appropriate procedure and correct answer
3 marks	Appropriate procedure, but incorrect answer due to a minor error, such as a calculation or transcription error, or missing unit of measure
2 marks	Appropriate procedure, but incorrect answer due to a major error such as the incorrect application of a law, formula or rule (e.g. student forgot to take friction into account or used the wrong trigonometric ratio i.e. cos 35°)
1 mark	Partially appropriate procedure (e.g. student did not take the angle into account)
0 marks	Inappropriate procedure, or did not provide a procedure, regardless of the answer

Question 24

Example of an appropriate procedure

1. Energy of Spring 1 (2 significant figures):

$E = ½\, kx^2$

$E = ½ \left(4.00 \times 10^2 \text{ N/m}\right)\left(0.092 \text{ m}\right)^2$

$E = 1.7 \text{ J}$

2. Energy of Spring 2 (2 significant figures):

$E = ½\, kx^2$

$E = ½ \left(6.000 \times 10^2 \text{ N/m}\right)\left(0.062 \text{ m}\right)^2$

$E = 1.2 \text{ J}$

Note: Significant figures ***are*** taken into consideration in this question.

Answer

Team 1's spring has a stored elastic potential energy of **1.7 J** (significant figures).
Team 2's spring has a stored elastic potential energy of **1.2 J** (significant figures).

Marking Scale

4 marks	Appropriate procedure and correct answer
3 marks	Appropriate procedure, but incorrect answer due to a minor error, such as a calculation or transcription error, or missing unit of measure or student did not take significant figures into account
2 marks	Appropriate procedure, but incorrect answer due to a major error such as the incorrect application of a law, formula or rule (e.g.one spring calculated correctly)
1 mark	Partially appropriate procedure (e.g. student calculated the force applied on the spring (kx) rather than the energy stored ($½\, kx^2$)
0 marks	Inappropriate procedure, or did not provide a procedure, regardless of the answer

Question 25

Example of an appropriate procedure

1. Mechanical energy at the bottom of the ramp:

$$E_{bottom} = mgh + ½\,mv^2$$
$$E_{bottom} = (0.05\text{ kg})(9.8\text{ N/kg})(0.04\text{ m}) + ½\,(0.05\text{ kg})(13\text{ m/s})^2$$
$$E_{bottom} = 0.02\text{ J} + 4.23\text{ J}$$
$$E_{bottom} = 4.25\text{ J}$$

2. Mechanical energy at the top of the ramp:

$$E_{bottom} + E_{loss} = E_{top}$$
$$4.25\text{ J} + 2\text{ J} = 6.25\text{ J}$$

3. Speed of marble at the top of ramp:

$$E_{top} = mgh + ½\,mv^2$$
$$6.25\text{ J} = (0.05\text{ kg})(9.8\text{ N/kg})(0.17\text{ m}) + ½\,(0.05\text{ kg})v^2$$
$$6.25 = 0.083 + 0.025\,v^2$$
$$6.167 = 0.025\,v^2$$
$$v^2 = 246.68$$
$$v = 15.7\text{ m/s}$$

Note: Significant figures are not taken into consideration in this question.

Answer

The speed of the marble once it has been hit by the lever is **15.7 m/s**.

Note: If the student neglects the potential energy of the marble at the bottom of the ramp, the student may still arrive at the correct answer. In this case, the student should only be given 2 marks.