 Rainbow Challenge

Stage 5 Physical world

Outcomes

Values and attitudes

SC5-1VA A Student appreciates the importance of science in their lives and the role of scientific inquiry in increasing understanding of the world around them

SC5-3VA A Student demonstrates confidence in making reasoned, evidence-based decisions about the current and future use and influence of science and technology, including ethical considerations

Working scientifically

WS4 A student: develops questions or hypotheses to be investigated scientifically

b. predicting outcomes based on observations and scientific knowledge

WS5: A student: produces a plan to investigate identified questions, hypotheses or problems, individually and collaboratively

WS5.3 Students choose equipment or resources for an investigation by:

a. identifying appropriate equipment and materials

WS6: A student: undertakes first-hand investigations to collect valid and reliable data and information, individually and collaboratively

Students conduct investigations by:

a. individually and collaboratively using appropriate investigation methods, including fieldwork and laboratory experimentation, to collect reliable data (ACSIS165, ACSIS199) PSC

b. safely constructing, assembling and manipulating identified equipment WE

f. evaluating the effectiveness of the planned procedure, considering risk factors and ethical issues, and suggesting improvements as appropriate CCTEUWE

WS8: A student applies scientific understanding and critical thinking skills to suggest possible solutions to identified problems

WS8 Students solve problems by:

a. describing strategies to develop a range of possible solutions to an identified problem

b. assessing strategies that have been identified as possible solutions to an identified problem

c. applying the processes of Working Scientifically in developing creative solutions to problems CCTEUPSC

d. using cause-and-effect relationships to explain ideas

e. using models to explain phenomena and make predictions NCCT

f. applying critical thinking in considering suggested proposals, solutions and conclusions, including a consideration of risk CCT

g. evaluating different approaches used to solve problems (ACSIS172, ACSIS206)

Knowledge and understanding

PW1 Energy transfer through different mediums can be explained using wave and particle models.

Students:

b. identify situations where waves transfer energy

c. describe qualitatively, using the wave model, the features of waves including wavelength, frequency and speed

e. relate the properties of different types of radiation in the electromagnetic spectrum to their uses in everyday life, including communications technology

f. describe the occurrence and some applications of absorption, reflection and refraction in everyday situations

Learning across the curriculum

Cross-Curriculum priorities

Aboriginal and Torres Strait Islander histories and cultures Decorative

Asia and Australia's engagement with Asia Decorative

Sustainability Decorative

General capabilities

Critical and creative thinking Decorative

Ethical understanding Decorative

Information and communication technology capability Decorative

Intercultural understanding Decorative

Literacy Decorative

Numeracy Decorative

Personal and social capability Decorative

Other areas of learning

Civics and citizenship Decorative

Difference and diversity Decorative

Work and enterprise Decorative

Teacher notes

Due to the STEM nature of this activity additional assessment can be made on the mathematics and engineering components such as identifying the required distances ad angle of refraction of each wavelength of light and predetermining the position of each component in the design phase using the calculated angles required. This helps students explore the maths within science and engineering in a practical hands-on way. Students may also explore possible technologies that use these properties or even how these properties can be used in future technologies.

* This is a template task. This means the format of this task can be applied to any Problem Based Learning challenge or approach. Any challenge can be substituted and subsequently only require minor changes to the marking rubric and syllabus links, for example the rainbow can be substituted for a radiometer and the outcome being investigated is their knowledge of how waves transfer energy. Additionally, another idea could be to create a model that moves under wind power to explore Newton’s Laws of Motion. This task can even be expanded to a larger Rube Goldberg machine that incorporates a range of scientific knowledge and skills.
* This task is designed to investigate how students work together as a team to apply the scientific knowledge and skills they have learned during class to a new or novel situation. This requires a particular focus in teaching the students explicit teamwork, leadership and communication skills as outlined in the Working Scientifically outcomes. The task is expected to take one period of up to an hour.
* This challenge has been tested using the sun outside in the garden being reflected into the classroom off a variety of mirrors into a dark corner. Along its path it is focused using the lenses and refracted using the prism.
* The ‘target’ should be small enough to present a significant challenge to overcome but not too small. A ‘target’ area of between 5cm x 5cm - 10cm x 10cm should suffice. If using the rainbow option it should be in a dark location where the rainbow will be clearly visible. Some have even made the target inside an enclosed box. It is up to the teacher’s discretion and their interpretation of the students’ capabilities to determine a suitable target and location. To challenge students, the target location can be determined.
* The questionnaire at the end is designed to illicit the specific knowledge and understanding of the scientific outcomes by each of the team members. It allows evidence of student learning and provides an avenue to record student responses for NESA requirements and the requirements of the school and community.
* Teachers can adapt the questionnaire into a final presentation to the class through a video presentation, PowerPoint, verbal explanation or any other method deemed appropriate.
* The marking rubric only assigns a small portion of marks to whether or not the teams succeed in generating a rainbow. This is done for two reasons: to reward those who do succeed in the challenge, and; place an emphasis on working collaboratively and apply scientific knowledge. Students should be encouraged to learn from mistakes and use trial and error. The task is designed to assess how students accomplish the task.
* Most if not all marking can be done in class at the time of assessment reducing the amount of post activity marking but also allowing immediate feedback to each student.
* The peer assessment component is an avenue for students to critically examine their role and the role of others in group work. It can be used in post activity debriefs to help facilitate future teamwork and leadership opportunities. Each student should be encouraged to identify areas of strength and areas for improvement when working collaboratively.
* STEM Extension: this task can be adapted easily to become a STEM task with additional mathematical and engineering components for example students might need to calculate distances and the required angle based on the refraction of each wave length prior to setting up the equipment.

Introduction

Sometimes the greatest innovation comes from looking at an issue from different perspectives. A solution to one problem in a classroom can inspire solutions to other problems out in the real world. In class you have learned about refraction and reflection as well as how different lenses and mirrors can help you manipulate light.

Task

In this task you will be asked to put your creative thinking skills to the test and apply what you have learned in class. You will also need to use teamwork, leadership and communication skills to accomplish this challenge.

Your team is charged with casting a rainbow onto 10cm x 10xm target placed on a wall in a dark corner of your classroom. You may ONLY use the equipment provided to you and you must be able to explain why you have chosen to solve the problem the way you have. You will need to work in groups of 3-4 students and you will have 30 minutes to complete your task. You will have another 15 minutes to complete a short questionnaire relating to your solution.

You will be provided with the following items

* 1x piece of grid paper to plan out your solution
* 1x glass convex lens
* 1x glass concave lens
* 1x glass triangular prism
* 4x small hand mirrors
* 2x Retort Stands with boss heads and clamps
* 1x source of bright non directional white light (e.g. the sun outside or a portable bright lamp)
* 1x stop watch

You will be marked on teamwork, leadership and communication skills as well as your overall contribution to the group. You will also be marked on your understanding of refraction and reflection, the different lenses and prisms and mirrors and how it can be applied in this situation. Lastly you will be marked on the applications of your solution outside of school.

Peer assessment for student

Use the following table to describe the contributions of yourself and your team members.

| Task | Myself | Team member 1 | Team member 2 | Team member 3 |
| --- | --- | --- | --- | --- |
| Ability to listen to suggestions from other team members |  |  |  |  |
| Ability to communicate their ideas to the group |  |  |  |  |
| Demonstrated leadership of the group |  |  |  |  |
| Ability to work as an effective team member |  |  |  |  |
| Role in group work |  |  |  |  |
| Overall contribution to the group task |  |  |  |  |

Questions for consideration

1. Identify three strengths you displayed in this task?
2. Identify an area you could improve from this task and how you would do this.

Student questions

| Question | Response | Explanation |
| --- | --- | --- |
| Did you use convex lenses?  If yes how and why did you use them? If no, why not? | Yes  No |  |
| Did you use concave lenses?  If yes how and why did you use them? If no, why not? | Yes  No |  |
| Did you use a prism?  If yes how and why did you use it? If no, why not? | Yes  No |  |
| Did you use mirrors?  If yes how and why did you use them? If no, why not? | Yes  No |  |
| Where is refraction and reflection of EM waves used in everyday life? | Yes  No |  |
| Describe an application of your solution. Where could it be used in everyday life? | Yes  No |  |
| What would you change or improve for next time and why? | Yes  No |  |

Marking guideline/rubric

The following achievement levels are referenced in the rubric

* Elementary - Understanding and working with support
* Developing - Understanding – developing skills and knowledge
* Competent - Understanding and achieving all outcomes
* Highly developed - Confident understanding demonstrating secure skills and knowledge
* Outstanding - Perceptive and sophisticated understanding demonstrating outstanding skills and knowledge

| Outcomes | Non-submission | Elementary | Developing | Competent | Highly developed | Outstanding |
| --- | --- | --- | --- | --- | --- | --- |
| Challenge  Success | Did not get a rainbow at all | Got a faint small rainbow not near the target area | Got an obvious rainbow but not near the target areas | Got a faint rainbow near the target area | Got an obvious rainbow near the target area | Got an obvious rainbow in the target area |
| Teamwork | Did not work in a group | Worked towards group goals only when prompted by team members or teachers. | Worked towards group goals with frequent prompting from team members or teachers. | Worked towards group goals with occasional prompting from team members or teachers | Worked towards group goals with occasional prompting however accepted responsibility for role within the group | Consistently and actively worked towards the group goals and fulfilled individual role within the group. |
| Leadership | Did not demonstrates any leadership | Struggled to accept group role or communicate clear goals to the group. | Took initiative and attempted to set clear goals for the group | Took ownership of group role and helped set and work towards clear goals well communicated to other team members | Took ownership of group role and helped set and work towards clear goals well communicated to other team members. Attempted to utilise an appropriate leadership style to guide and direct the group. | Took ownership of group role and helped set and work towards clear goals well communicated to other team members. Utilised an appropriate leadership style to strategically guide and direct the group. |
| Communication | Did not communicate with team members | Needs constant teacher intervention to listen to each other and speak to each other appropriately | Need frequent teacher intervention to listen to each other and speak to each other appropriately. | Need some teacher intervention to be able to listen to each other and speak to each other appropriately. | Listen to each other and speak to each other in equal amounts. | Listens well to other members. Each member speaks in respectful and encouraging ways. |
| Participation | Did not participate | Took over contribution and did all the work and did not let others do anything | Did not contribute a fair share of the workload | Did a fair share of the workload with prompts and reminders from team member or teachers | Contributed equally without prompts or reminders. | Contributed equally, and more than was required |
| Explanation:  EM Spectrum | Could not explain the cause and effect | Basic information presented in a way not appropriate for the task. | Limited information explained with language not suitable for target audience. | Sufficient information explained using appropriate language for the target audience. | Through information well explained using appropriate language for the target audience. | In-Depth information clearly explained using appropriate scientific language for the target audience. |
| Explanation: Convex and Convex Les | Could not explain the function of a Convex sense | Basic information presented in a way not appropriate for the task. | Limited information explained with language not suitable for target audience. | Sufficient information explained using appropriate language for the target audience. | Through information well explained using appropriate language for the target audience. | In-Depth information clearly explained using appropriate scientific language for the target audience. |
| Explanation: Prism | Could not explain the function of the prism | Basic information presented in a way not appropriate for the task. | Limited information explained with language not suitable for target audience. | Sufficient information explained using appropriate language for the target audience. | Through information well explained using appropriate language for the target audience. | In-Depth information clearly explained using appropriate scientific language for the target audience. |
| Explanation: Mirrors | Could not explain the function of the mirrors | Basic information presented in a way not appropriate for the task. | Limited information explained with language not suitable for target audience. | Sufficient information explained using appropriate language for the target audience | Through information well explained using appropriate language for the target audience | In-Depth information clearly explained using appropriate scientific language for the target audience. |
| Connection to Real world | No possible adaptations for the outside world | Basic information presented in a way not appropriate for the task. | Limited information explained with language not suitable for target audience | Sufficient information explained using appropriate language for the target audience. | Through information well explained using appropriate language for the target audience. | In-Depth information clearly explained using appropriate scientific language for the target audience. |
| Evaluation of project | No evaluation completed | Limited attempt at an evaluation of strengths or weaknesses completed | An evaluation of strengths or weaknesses completed with no suggestions for changes or improvements. | An evaluation of strengths or weaknesses completed with some suggestions for changes or improvements. | A sufficient evaluation of strengths and weaknesses with appropriate suggestions for changes or improvements. | Thoughtful evaluation of strengths and weaknesses with appropriate suggestions for changes or improvements |
| Self-reflection | Demonstrates no awareness of own strengths and weaknesses and gives no consideration to the learning experience. | Demonstrates a basic awareness of either own strengths or weaknesses with little consideration to the learning experience | Demonstrates a limited awareness of own strengths and weaknesses and gives some consideration to the learning experience | Demonstrates a sufficient awareness of own strengths and weaknesses and gives structured consideration to the learning experience | Demonstrates a thorough awareness of own strengths and weaknesses and gives thoughtful consideration to the learning experience | Demonstrates an in-depth awareness of own strengths and weaknesses and gives insightful consideration to the learning experience |