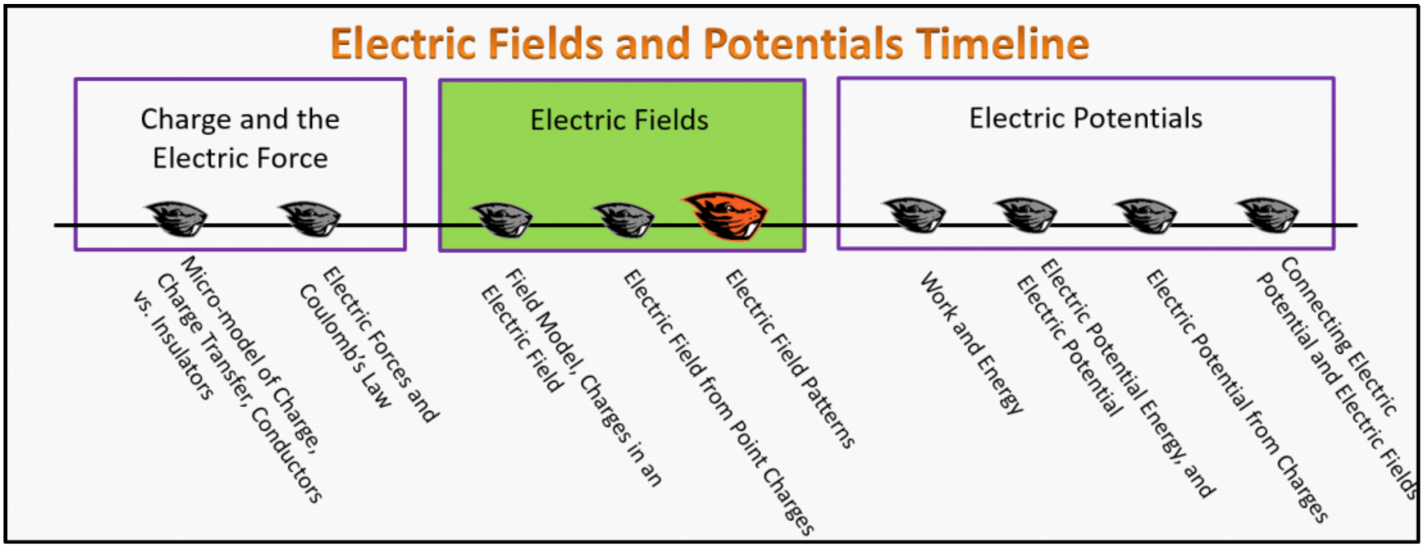
EP.L1.2 - NewTemplate

Monday, May 6, 2019 7:10 AM

Electric Potentials
Foundation Stage (EP.2.L1)

Lecture 3
Electric Field Patterns



Textbook Chapters (* Calculus version)

- **BoxSand** :: KC videos (Electric Potentials)
- **Knight** (College Physics : A strategic approach 3rd) :: 21.1 ; 21.2 ; 21.3 ; 21.4
- ***Knight** (Physics for Scientists and Engineers 4th) :: 25.1 ; 25.2 ; 25.6
- **Giancoli** (Physics Principles with Applications 7th) :: 17-1 ; 17-3 ; 17-5 ;

Warm up

EP.2.L1-1:

Description: List types of energies.

Learning Objectives: [?]

Problem Statement: Yell out all of the types of energies you know of.

Selected Learning Objectives

1. Coming soon to a lecture template near you.

Key Terms

- Electric Potential Energy
- Electric Potential

Key Equations

Key Concepts

- Coming soon to a lecture template near you.

Questions

Act I: Work-Energy Theorem Review

EP.2.L1-2:

Description: Conceptual question about energy.

Learning Objectives: [?]

Problem Statement: Energy is a

(1) vector.
(2) scalar.
(3) tensor.

EP.2.L1-3:

Description: Identify the work-energy theorem model that best describes a given system. (3 minutes + 3 minutes)

Learning Objectives: [?]

Problem Statement: Which work-energy mathematical model best represents the given scenario?

(a) A ball of mass **m** initially at rest falls from some height above the surface of the Earth. The ball lands on a spring compressing it a distance **y** from the springs equilibrium position. The system is the ball, earth, and spring. Ignore air resistance and sounds.

(1) $KE_{T,i} + U_i^g + U_i^S + E_i^{Chem} + W^{Ext} = KE_{T,f} + U_f^g + U_f^S + E_f^{Chem}$

(2) $KE_{T,i} + U_i^g + U_i^S + U_i^E = KE_{T,f} + U_f^g + U_f^S + U_f^E$

(3) $KE_{T,i} + U_i^g + U_i^S = KE_{T,f} + U_f^g + U_f^S$

(4) $KE_{T,i} + U_i^g + U_i^S + E_i^{Chem} + U_i^E = KE_{T,f} + U_f^g + U_f^S + E_f^{Chem} + U_i^E$

(b) A ball of mass **m** and net charge **q** initially at rest falls from some height above the surface of the Earth. The ball falls through an external electric field throughout the entire time and lands on a spring compressing it a distance **y** from the springs equilibrium position. The system is the ball, earth, electric field, and spring. Ignore air resistance and sounds.

(1) $KE_{T,i} + U_i^g + U_i^S + E_i^{Chem} + W^{Ext} = KE_{T,f} + U_f^g + U_f^S + E_f^{Chem}$

(2) $KE_{T,i} + U_i^g + U_i^S + U_i^E = KE_{T,f} + U_f^g + U_f^S + U_f^E$

(3) $KE_{T,i} + U_i^g + U_i^S = KE_{T,f} + U_f^g + U_f^S$

(4) $KE_{T,i} + U_i^g + U_i^S + E_i^{Chem} + U_i^E = KE_{T,f} + U_f^g + U_f^S + E_f^{Chem} + U_i^E$

Act II: Electric Potential and Electric Potential Energy

EP.2.L1-4:

Description: Conceptual question about electric potential. (2 minutes)

Learning Objectives: [?]

Problem Statement: Electrons create

(1) Electric fields.
(2) Electric potential fields.
(3) Gravitational fields.
(4) UV fields.

EP.2.L1-5:

Description: Conceptual question about gravitational potential. (4 minutes)

Learning Objectives: [?]

Problem Statement: Recall that gravitational potential energy near the surface of the earth is $\mathbf{U^g = m_o\, g\, y}$, where **y** is the vertical height above, or below, a horizontal reference line. What is the gravitational potential field? Hint: you stick a mass in this field.

(1) $m_o\, g\, y$

(2) g

(3) y

(4) g y

(5) U^g/m_o

(6) U^E/q_o

EP.2.L1-6:

Description: Calculate the change in gravitational potential near the surface of the earth, and the change in gravitational potential energy for a given system. Calculate initial speed given via work-energy theorem. (2 minutes + 2 minutes + 1 minute + 4 minutes)

Learning Objectives: [?]

Problem Statement: Mary's Peak is approximately 1,200 meters higher in elevation than Corvallis. Approximate the free fall acceleration as **g** = 10 m/s^2.

(a) Calculate the change in gravitational potential (Δ**GP**) between Corvallis and Mary's Peak ($\mathbf{GP}_{Mary}$ - $\mathbf{GP}_{Corvallis}$)

(1) 120 m^2/s^2
(2) 1,200 m^2/s^2
(3) 12,000 m^2/s^2
(4) 1,210 m^2/s^2

Superman throws a 2 kg brick of kryptonite vertically upwards near the surface of the earth. The brick travels through the same change in height between Corvallis and Mary's Peak before it momentarily stops and begins falling back down.

(b) What is the change in gravitational potential energy of the brick? (1) -2,400 kg·m^2/s^2 (2) 2,400 kg·m^2/s^2 (3) 24,000 kg·m^2/s^2 (4) -24,000 kg·m^2/s^2	**(c)** What is the change in kinetic energy of the brick assuming no air resistance? (1) -2,400 kg·m^2/s^2 (2) 2,400 kg·m^2/s^2 (3) 24,000 kg·m^2/s^2 (4) -24,000 kg·m^2/s^2

(d) What as the initial speed that superman threw the brick?

Act III: Electric Potential from Point Charge

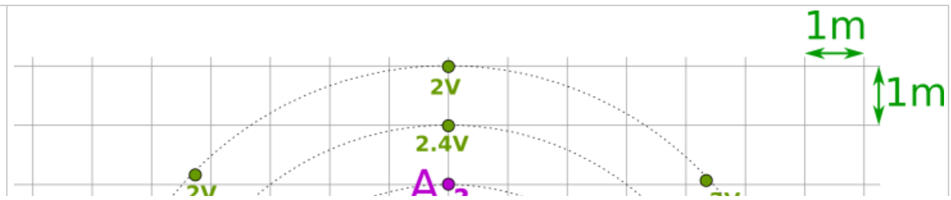
EP.2.L1-7:

Description: Calculate the electric potential at a point in space near a single point charge. Find final speed of test charge that moves through a change in electric potential. (3 minutes + 3 minute + 1 minutes + 1 minute + 1 minute + 2 minutes + 1 minute + 2 minutes + 4 minutes + 2 minutes + 4 minutes)

Learning Objectives: [?]

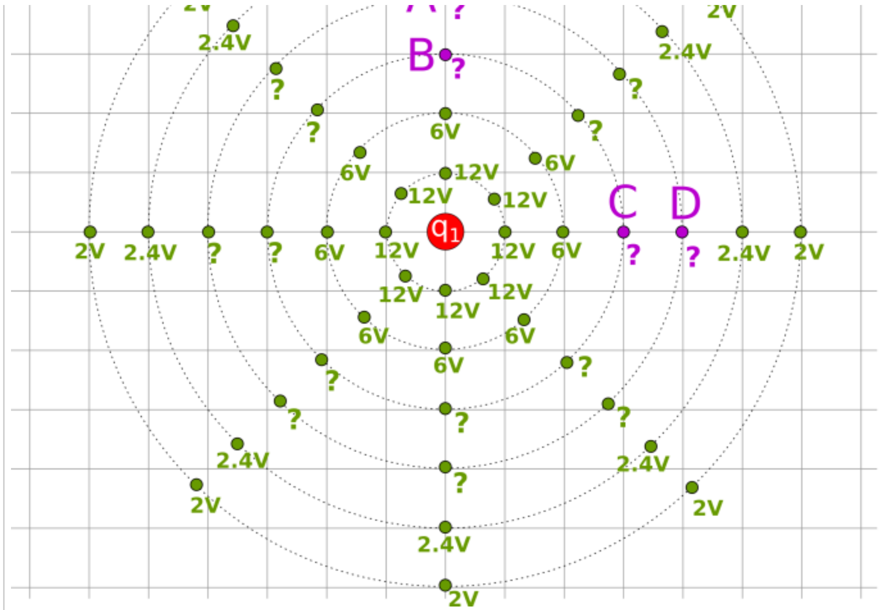
Problem Statement: Ella the Electrical Engineering Elephant began mapping out the electric potential around a single point charge of **q_1** = (4/3) x 10^{-9} C as seen in the figure below. Unfortunately Ella forgot to write down the potential at a few locations marked by the question marks. Let **k** = 9 x 10^9 N·m^2/C^2.

(a) What is the electric potential at **A**?



(b) What is the electric potential at **C**?

(c) What is the electric potential at **B**?



(d) What is the electric potential at **D**?

(e) What are the dashed lines often referred to as?

(1) Electric field lines
(2) Electric potential lines
(3) Equipotential lines
(4) Latitude lines
(5) Longitude lines

(f) A positive test charge $\mathbf{q_o}$ is placed at location **C** initially at rest. What direction does $\mathbf{q_o}$ begin to move?

(1) Up
(2) Down
(3) Left
(4) Right

(g) What is the change in electric potential from **C** to **D** (ΔV_{CD})?

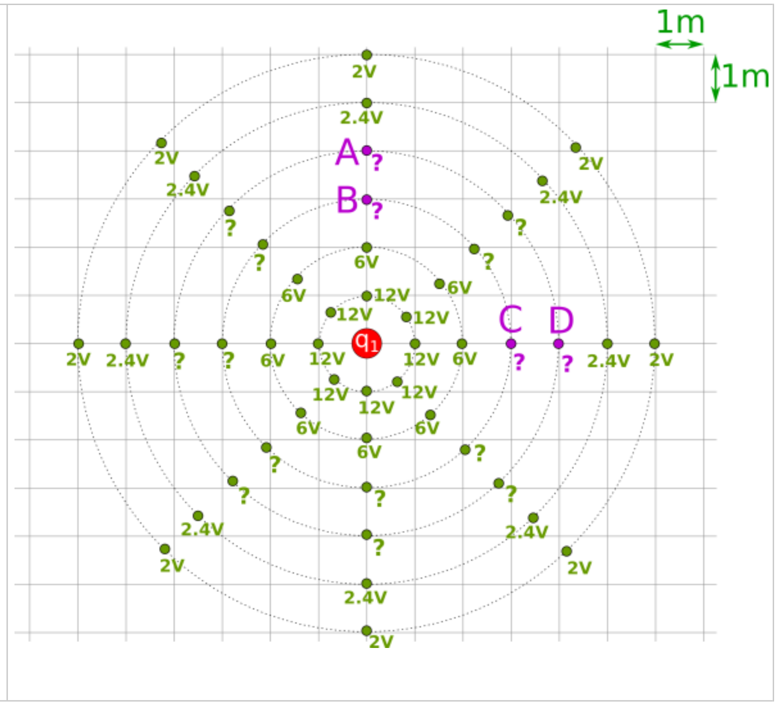
(h) What is change in electric potential energy of the system from **C** to **D** ($\Delta \mathbf{U^E}$)?

(i) A proton is placed at location **C** initially at rest. What is the speed of the proton at location **D**? $\mathbf{m_p}$ = 1.67 x 10^{-27} kg.

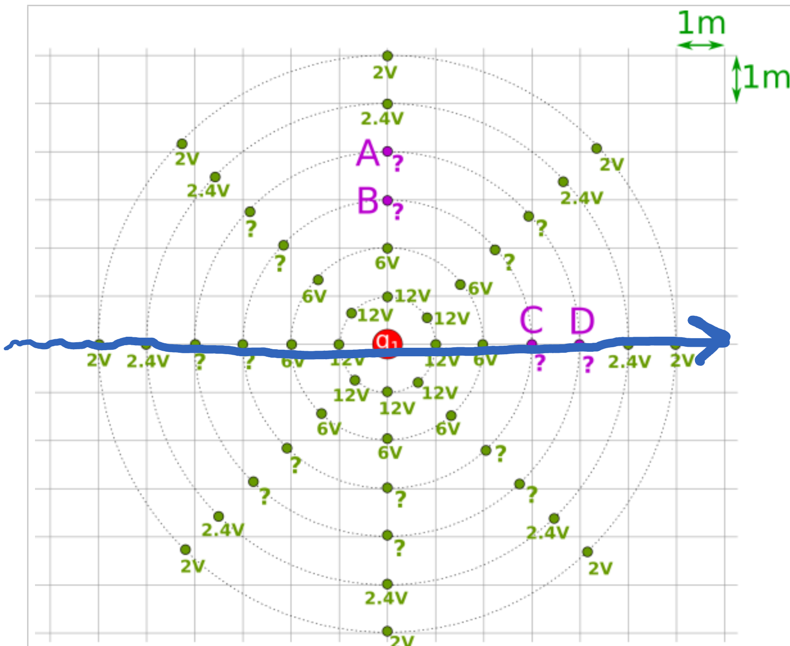
(j) An electron is placed at location **D** initially at rest. What direction does the electron begin to move?

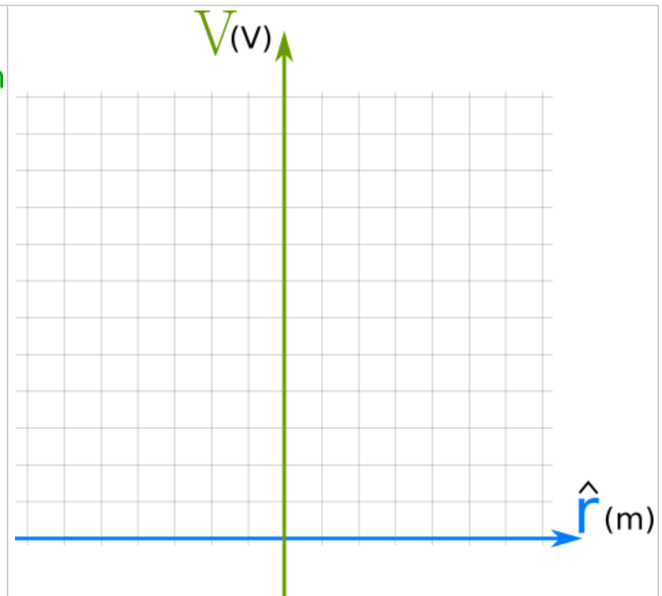
(1) Up
(2) Down
(3) Left
(4) Right

(k) What is the speed of the electron after it has traveled 2 meters in the direction from part **(j)**? $\mathbf{m_e} = 9.11 \times 10^{-32}$ kg.



(l) Consider the direction indicated in the figure below. Sketch the electric potential vs position along the direction on the provided graph.





(m) What does this function $\mathbf{V}(\mathbf{r})$ look like?

	(1) **V** proportional to **r** (2) **V** proportional to 1/**r** (3) **V** proportional to 1/$\mathbf{r}^3$ (4) **V** proportional to constant (5) **V** proportional to - $\mathbf{r}^2$

Act IV: Electric Potential from Multiple Point Charges

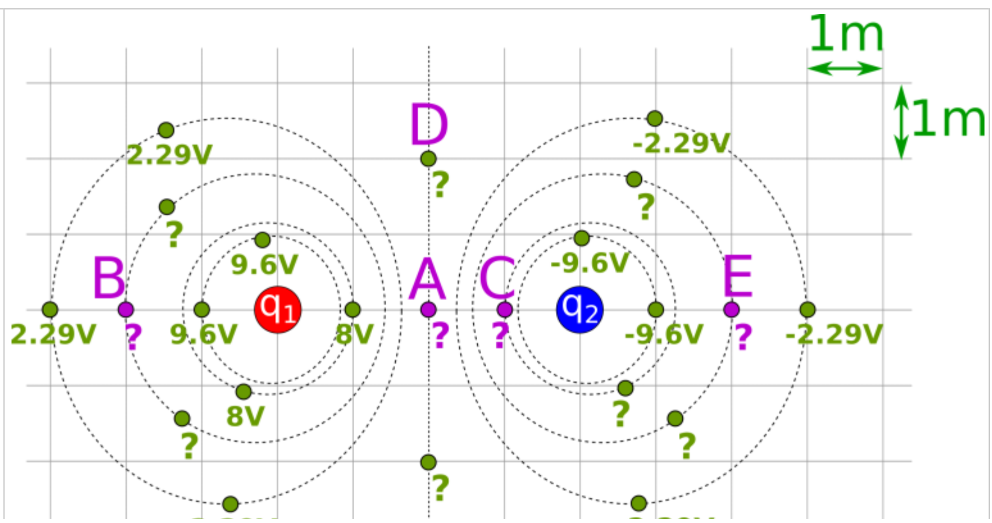
EP.2.L1-8:

Description: Calculate the electric potential at a point in space near two point charges. Find final speed of test charge that moves through a change in electric potential. (3 minutes + 3 minute + 1 minutes + 1 minute + 2 minutes + 1 minute + 2 minutes + 5 minutes)

Learning Objectives: [?]

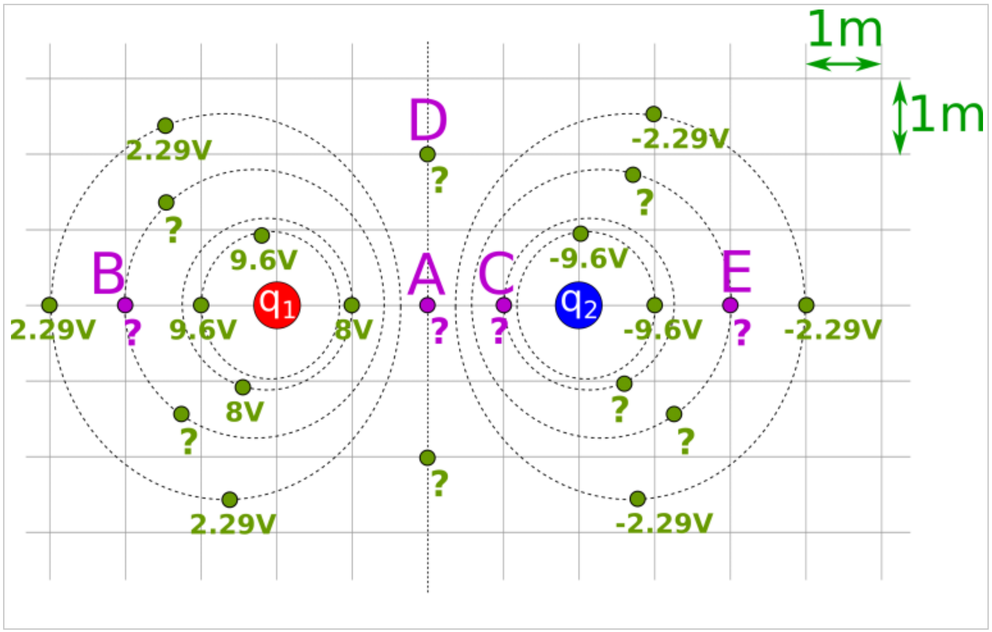
Problem Statement: Erza the Electrical Eel Electrician began mapping out the electric potential around two point charge of $\mathbf{q_1}$ = (4/3) x 10^{-9} C and $\mathbf{q_2}$ = - (4/3) x 10^{-9} C as seen in the figure below. Unfortunately Erza forgot to write down the potential at a few locations marked by the question marks. Let **k** = 9 x 10^9 N·m^2/C^2.

(a) What is the electric potential at **A**?



(b) What is the electric potential at **B**?

	
(c) What is the electric potential at **C**?	**(d)** What is the electric potential at **E**?



(f) A positive test charge $\mathbf{q_o}$ is placed at location **D** initially at rest. It is observed that $\mathbf{q_o}$ passes through location **E**. What trajectory did $\mathbf{q_o}$ most likely take?

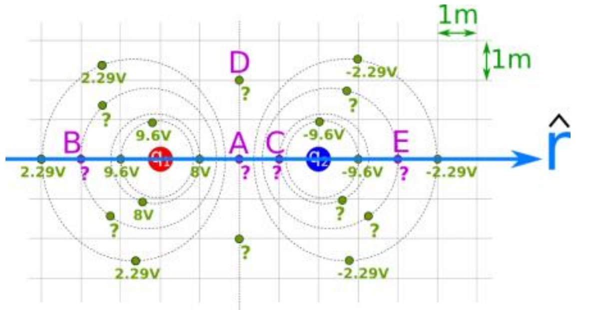
(1) Direct path from **D** to **E**.
(2) Initially travels to the left eventually turning around and passing through **E**.
(3) Initially travels to the right and then follows the equipotential line through **E**.
(4) Some other trajectory.

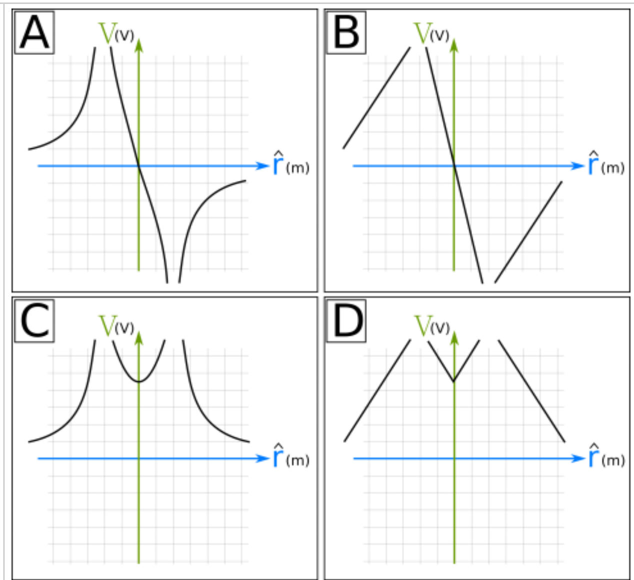
(g) What is the change in electric potential from **D** to **E** (ΔV_{DE})?	**(h)** What is change in electric potential energy of the system from **D** to **E** (ΔU^E)?

(i) A proton is placed at location **D** initially at rest. What is the speed of the proton at location **E**? $\mathbf{m_p}$ = 1.67 x 10^{-27} kg.

(j) Which of the following graphs best represent the electric potential as a function of the radial direction shown in the image below?

(1) A
(2) B
(3) C
(4) D





Conceptual questions for discussion

1. Coming soon to a lecture template near you.

Hints

EP.2.L1-1: No hints.

EP.2.L1-2: No hints.

EP.2.L1-3: No hints.

EP.2.L1-4: No hints.

Ep.2.L1-5: No hints.

EP.2.L1-6: No hints.

EP.2.L1-7: No hints.

EP.2.L1-8: No hints.