EO C440.09 – DESCRIBE THE RELATIONSHIP BETWEEN GRAVITY AND SPACE-TIME

1. **Performance**: Describe the Relationship Between Gravity and Space-Time
2. **Conditions**:
   a. Given:
      (1) Supervision, and
      (2) Assistance as required.
   b. Denied: Nil.
   c. Environmental: Classroom or training area large enough to accommodate the entire group.
3. **Standard**: The cadet shall describe the relationship between gravity and space-time, to include:
   a. classical explanations of gravity, and
   b. relativistic explanations of gravity and space-time.
4. **Teaching Points**:

TP	Description	Method	Time	Refs
TP1	Compare early ideas of gravity to gravitation under the theory of relativity, to include: a. Newton's Universal Law of Gravitation, b. gravity as a force between masses, c. instantaneous transmission of gravity, d. the interdependence of space and time, and e. curvature of space-time.	Interactive Lecture	10 min	C3-310 C3-312
TP2	Describe the Gravity Probe B (GP-B) mission, to include: a. gyroscope operation, b. the spin-axis of a gyroscope, c. geodetic effect, d. frame-dragging effect, e. spacecraft components, and f. Canada's contribution to orientation control.	Interactive Lecture	10 min	C3-310 C3-312
TP3	Have the cadets watch *Testing Einstein's Universe* while finding answers to assigned questions, to include: a. tests of the 20th century, b. the concept of GP-B, c. mechanics of GP-B, and d. components of the GP-B spacecraft.	In-Class Activity	25 min	C3-311

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TP	Description	Method	Time	Refs
TP4	Conduct an activity to correct answers to the assigned questions.	In-Class Activity	5 min	C3-310

5. **Time**:

a.	Introduction:	10 min
b.	Interactive Lecture:	20 min
c.	In-Class Activity:	30 min
d.	Total:	60 min

6. **Substantiation**:

   a. An interactive lecture was chosen for TPs 1 and 2 to introduce theories of gravitation and give an overview of the Gravity Probe B mission.

   b. An in-class activity was chosen for TPs 3 and 4 as it as it is an interactive way to reinforce the relationship between gravity and space-time, provoke thought, and stimulate interest among cadets.

7. **References**:

   a. C3-310 Range, S. K. (2004). *Gravity Probe B: An educator's guide*. Washington, DC: NASA. Retrieved February 6, 2009, from http://einstein.stanford.edu/RESOURCES/education-index.html#guide

   b. C3-311 Bartel, N. (Producer & Director). (2003). *Testing Einstein's universe* [Motion picture]. Canada: York University.

   c. C3-312 Range, S. K. (2008). *Gravity Probe B: Testing Einstein's universe*. Retrieved February 6, 2009, from http://einstein.stanford.edu/index.html

8. **Training Aids**:

   a. Presentation aids (eg, whiteboard / flip chart / OHP / multimedia projector) appropriate for the classroom / training area,

   b. WMV video file *Newtons_Universe_Anima* from Reference C3-312,

   c. WMV video file *Einsteins_Universe_Anima* from Reference C3-312,

   d. WMV video file *Rel_gyro_expt-anima* from Reference C3-312,

   e. WMV video file *Simple_expt_anima* from Reference C3-312,

   f. WMV video file *DF-Satellite* from Reference C3-312,

   g. WMV video file *SConSquid* from Reference C3-312, and

   h. *Testing Einstein's Universe* DVD.

9. **Learning Aids**: Nil.

10. **Test Details**: Nil.

11. **Remarks**: Nil.

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