ACTAR Examination Preparation Guide

Review this guide carefully. There have been **changes** and **additions** compared to previous versions.

January 2022

Part I - Theory Examination

The questions that make up the Theory Portion of the Examination are formatted as either true-false, multiple choice or problem solving. The questions are drawn at random from a database of questions.

The ten general topic areas from which test questions are drawn are, (in no particular order):

- □ Airborne equations and problems
- □ Kinetic energy equations and problems
- □ Lamp examination
- □ Scene measurements and examination
- □ Momentum equations and problems
- □ Roadway marks and evidence
- □ Time and distance equations and problems
- □ Tire marks and tire evidence
- □ Vehicle evidence questions
- □ Change in Velocity (Δv) and Principal Direction of Force (*pdof*)

Part II - Practical Examination

During the Practical portion of the examination, the candidate will complete an accident reconstruction case based on problem data provided by ACTAR. The case problem is based on controlled crash tests conducted by ACTAR and will have objective and definitive answers.

The candidate will be given a scale scene diagram depicting the physical evidence documented at the scene of the crash, photos of the vehicles and scene, as well as other information in narrative form.

Using that information, the candidate will have to analyze the case problem. The candidate will be required to properly locate vehicle positions at specific locations and **draw the vehicle on their diagram**. Taping or otherwise affixing transparent or onion skin drawings of vehicles on the diagram is not acceptable. Approach and departure angles of the involved vehicles will have to be established and **drawn on the diagram** so a momentum analysis can be completed. The candidate will then answer a series of questions regarding the case.

In addition to questions related to the diagramming described previously, the questions that make up the Practical Portion of the Examination require calculations to determine pre-impact and post-impact speeds, Principal Direction of Force (PDOF), Delta-V, time/distance considerations and basic occupant kinematics.

ACTAR recognizes that candidates typically rely upon computer software to conduct reconstructions on a day-to-day basis. However, to verify an examination candidate's abilities, it is required that the Practical portion of the examination be completed without the use of a computer and computer software. **It is highly recommended that candidates review and practice the process of completing a reconstruction using the items recommended below.**

Recommended tools for the diagramming portion of the Practical examination include standard traffic templates, protractor, engineering scale, colored pencils, transparency material and other drafting supplies the candidate feels may be helpful. All diagramming must be done by hand on the provided diagram sheet.

Reference Materials

Candidates participating in the examination will be allowed a reasonable amount of reference material with them in

the examination room during their participation in both portions of the examination **subject to the following limits. Materials permitted to be kept at the candidate's work area at an examination site are:**

- Examination booklet as provided by the examination proctor.
- Examination workbook as provided by the exam proctor.
- Approved calculator.
- Formula sheets, **provided they are laminated and bound within a 3-ring binder.**
- Momentum worksheets, **provided they are laminated and bound in a 3-ring binder.**
- Plastic "sleeves" may be used for Formula or Momentum worksheets, **provided they are bound in a 3-ring binder.** They may **not be removed or written on by the Candidate.**
- Bound textbook(s) and bound Equation Book(s) – (reference tabs are permitted).
- **No loose paper, legal pads, steno pads or note taking materials of any kind.**
- Small snacks and non-alcoholic liquid refreshments.
- Eyeglasses **(no case).**
- Ruler, protractor, scale and triangles or other drawing tools.
- Pens, pencils, and erasers.
- Scissors, plastic transparency material, acetate (or similar) and transparent tape.
- Wristwatch **(smart technology prohibited).**
- No electronic (pdf) reference materials are permitted.

*** No backpacks, briefcases, "banker boxes", plastic totes, or similar storage compartments or containers shall be permitted at the candidate's desk during the exam.**

<u>Electronic Devices</u>

Laptop computers are **not** allowed for use during the examination.

Cellular phones are **not** allowed in the examination room.

No scanning devices or printers will be permitted in the examination room. The wireless capabilities of any electronic device cannot be used during the examination process.

Any attempt to photograph, copy or otherwise enter any question(s) or examination data onto paper or into an electronic storage device for later retrieval will result in immediate disqualification of the candidate from the accreditation program.

Only those calculators/electronic devices "approved by ACTAR" will be permitted for use in the examination room. The use of laptop computers and many other electronic devices <u>will not</u> be permitted during the examination process. A list of approved electronic devices is included as the last page of this document.

The fundamental basis for this decision is to eliminate the use of devices that are capable of recording or otherwise storing examination data or questions thereby compromising the integrity and confidentiality of the examination.
A second, and perhaps more compelling reason for the elimination of computers, is that the use of advanced collision reconstruction software resulted in the failure of many examination candidates to adequately demonstrate a fundamental knowledge of crash reconstruction concepts, particularly when addressing the definitive responses sought by the examination.

During the Governing Board of Directors (GBOD) discussion that preceded this decision, several anecdotes and reviews of

examinations were presented that underscored the two concerns expressed above. The decision eliminates the use of all electronic devices that may employ accident reconstruction software such as smart phones, cell phones, PDAs, compact cameras and other wireless communication devices. If the device has a "*qwerty*" keyboard, **or is capable of imaging,** it will not be allowed.

After considering comments and concerns expressed by GBOD members and a review of rules and guidelines in place for other professional examinations - such as the SAT, ACT, the MCAT entrance examinations and the National Council of Examiners for Engineering and Surveying – the GBOD believes the positive aspects of this decision far outweigh the negative. The decision positions the ACTAR examination on par with the procedures of similar professional examinations; helps to ensure that the examination is testing the fundamental knowledge of the candidate and not their skill in the use of computer software; and improves examination security by minimizing the opportunity to copy, store or transmit examination material.

The list of approved electronic devices for use during the examination will be reviewed and updated as necessary at the Annual Meeting of the ACTAR Governing Board of Directors (GBOD) each spring.
See page eleven (11) for the current list of approved electronic devices.

Scoring Procedures

The questions are written such that the candidate will be asked to solve for specific distances, times or speeds and render conclusions based upon information provided. Answers will be graded as either correct or incorrect. Partial credit will not be given for any question. **A question that requires a numerical value will require not only the correct numerical answer, but also the proper units (e.g., feet, seconds, miles per hour or meters per second, etc)**.

For this examination, the term drag factor, is a number representing the acceleration or deceleration of a vehicle or other body as a decimal fraction of the acceleration of gravity (i.e., f = a/g) or the force needed to produce acceleration in the same direction as the force divided by the weight of the body to which the force is applied. When a vehicle slides with all wheels locked on a level surface, the coefficient of friction and the drag factor have the same value. This value is dimensionless and does not include units.

Answers given as ranges (e.g., 45-50 mph or 10-12 meters, etc) will not be accepted.

When the question offers a value (e.g., 20 meters, 1.5 seconds, etc), it is to be taken as an uncontroverted fact with which the candidate can solve the problem to a single value.

Answers to individual questions stand alone. Reliance on a previous incorrect answer may result in a subsequent answer that is outside the acceptable tolerance for that question and will be marked incorrect.

Grading, Retesting and Time Limits

To be awarded Accreditation, candidates must achieve a score of 75% or better on both the Theory and Practical portions of the examination. Scores will be recorded as either pass or fail. ACTAR does not retain nor disclose numeric scores.

Grading will not be done at the examination site. The examinations will be sent to the grading committee and will be graded later. **Expect that it may take up to 60 days for your exam to be graded three times before you are notified of your examination score.** Failed portions of the examination must be successfully

completed before the candidate's current eligibility period expires to attain accreditation.

Candidate Qualification and Eligibility

After a candidate's application for accreditation has been approved, the candidate is granted a two-year eligibility period to take the examination. The candidate may make no more than three attempts to successfully complete each portion of the examination. Only that portion of the examination that was failed need be retaken.

Candidates who fail to successfully complete both portions of the examination during their initial eligibility period may make a request to be granted an additional two-year eligibility period. **Payment of the equivalent of an application fee will be required**. When a new eligibility period is granted, both portions of the examination must be successfully completed during the new two-year eligibility period **regardless the success on one part during the previous two-year period**. Candidates will have three attempts during the second eligibility period to pass the exam. Any candidate who has not successfully passed the exam at the end of that second two-year period, **will not be allowed to sit for any future ACTAR examination.** This policy begins January 1, 2022, **for candidates qualified for the examination process for the first time after that date.**

For candidates qualified to sit for the exam, before January 1, 2022, this policy will take effect after the expiration of their current eligibility period. Those candidates will be limited to a maximum of two additional two-year eligibility periods.

Any additional eligibility period(s) need not be consecutive.

Examination Review

Candidates who fail an examination will receive a limited review of their examination attempt in written form. The review will indicate from which sections of the examination the candidate had incorrect answers. The review is not intended to be a mentoring session but is meant to provide the candidate with an understanding of concepts that may warrant additional study.

Additional Information

It is recognized that accreditation candidates have received their education, training, and experience through a variety of disciplines.

Regardless your background, when taking the examination please recognize that the Examination Committee has determined the single best answer for each question based on the information provided.

Unless otherwise stated in a particular question or given information, a 60/40 front/rear weight distribution will be assumed for the vehicles described in the Theory portion of the examination.

Several methods are currently in use to compute speed from skid marks. When asked to compute a minimum speed from a set of locked wheel skid marks, the distance the vehicle slid will be based on the average length of the different wheel's skid marks. In the case of overlapping skid marks where the length left by a particular tire cannot be determined, the distance the center of mass moved would be the overriding element.

The examination questions provide the candidate with all the requisite information to determine the effective or resultant drag factor for the problem statement at hand. If there is any confusion or concern for the candidate regarding a question, proctors will be available in the examination room.

Sample Examination Questions

These sample questions are not an indication of the level of difficulty or simplicity of the examination and do not reflect the full variety of questions the candidate might be faced with, but are representative of some of the questions which might be found on the examination.

1. The post impact departure angle of a unit involved in a collision is measured from the location of the center of mass of that unit in its position at impact to the center of mass of that unit at its point of rest post impact provided that unit had not been moved prior to the post impact position being documented.

a. True
b. False

2. In a 90º collision where the center of mass of one vehicle is aligned with that of the other vehicle, both vehicles will always achieve the same departure angle.

a. True
b. False

3. If the velocity of a vehicle is doubled, the amount of kinetic energy it has _____.

a. remains the same
b. quadruples
c. is halved
d. doubles

4. An auto in neutral takes 16.00 seconds to accelerate forward from 10 mph to 30 mph (16 to 48 km/h), in line with the run of a road. Was the road:

a. level
b. downhill
c. uphill
d. crowned or banked

5. The amount of overlap can best be determined by contact damage.

a. True
b. False

6. Tearing, breaking and punctures are examples of

a. eccentric damage
b. directed damage
c. induced damage
d. contact damage

7. Parallel fracture lines in laminated safety glass usually result from an occupant or some other object striking the windshield.

a. True
b. False

8. A car starts to skid from 80 mph (129 km/h). Assume a drag factor of 0.72 on the given roadway surface.

What will the car's speed be after it has slid 150 ft (46 m)?

How long, in seconds, will the speed reduction take?

Sample Examination Question Answers

1. B

2. B

3. B

4 B

5. A

6. D

7 B

8. 56 mph (90 km/h)

1.50 seconds

There will be four (4) scenario-based problems where a series of related questions will be asked based on the scenario provided. Two of these scenarios will have 10 questions, one will have 5 questions and one will have 3 questions.

Below are two examples of scenario problems. The questions based on the scenarios may ask for:

- Impact Speeds
- Post Impact Speeds
- Speed across a given surface
- Change in Velocity
- Kinetic Energy of the vehicle
- Principal Direction of Force
- Time to Travel a specific distance or from a specific point
- Vehicle's Drag Factor

Example Scenario #1

A Nissan, which weighs 3,850 pounds (1,746 kilograms), is traveling 15 degrees north of east when it strikes a Buick, which weighs 4,230 pounds (1,919 kilograms) and is traveling 10 degrees west of north. After the collision the Nissan is redirected 25 degrees towards the north while the Buick is redirected 45 degrees towards the east.

After the collision the Nissan slides across two surfaces before stopping. It expends 16,603 ft lbs. (22,511 J) of energy on the first surface which had a downhill grade of -4%, and 21,843 ft lbs. (29,615 J) on the second surface which had and uphill grade of 2%. Both surfaces have a coefficient of friction of 0.75.

The Buick had a post impact speed of 20 mph (32.2 km/h), traveling 40 feet (8.94 meters) on a surface with an uphill grade of 3% with a coefficient of friction of 0.78.

Prior to impact, the Nissan attempted to avoid the collision by locking up the brakes for 52 feet (15.85 meters), skidding with a drag factor of 0.8.

Prior to the impact the Buick was accelerating for a distance of 52 feet (15.85 meters) with an acceleration factor of 0.246.

Example Scenario #2

The driver of a vehicle locks up the brakes (100% braking) in an effort to avoid a vehicle crossing over into their lane of travel. Due to the curve in the roadway it skids off the road and strikes a tree head-on. In the process it skids across three surfaces, the first concrete, the second asphalt and the third grass. After the impact with the tree the 4250 pound (1928 kg) vehicle rebounds backwards with a speed of 5.1 mph (8.2 km/h). When it stuck the tree, it had 194,524 ft lb (263,740 J) of kinetic energy and 387,124 ft lb (524,870 J) of kinetic energy at the start of the second (asphalt) surface.

It traveled 55 feet (16.76 meters) on the first surface and 42 feet (12.8 meters) on the third surface with a drag factor of 0.38.

Testing established the coefficient of friction for the concrete surface was 0.82, 0.68 for the asphalt surface and 0.48 for the grass surface.

The asphalt surface had an uphill grade of 2% and the concrete surface had a downhill grade of 3%.

Guide for Reporting Numerical Answers
ACTAR Accreditation Examinations

For both the **THEORY** and **PRACTICAL** Examinations, the significant digits for all answers must be expressed as shown in the examples below.

Imperial answer should be shown:	Units	Metric answer should be shown:
0.75	Acceleration / Deceleration (drag factor)	0.75
25.7 fps^2	Acceleration Rate / Deceleration Rate	7.85 m/s^2
305°	Degrees	305°
10 in 10.2 ft	Distance	10 cm 10.00 m
87,338 ft lb	Energy	87,338 J
85,500 lb*mph	Momentum	85,500 kg*kph
5.10 %	Percent of grade / slope	5.10 %
25 mph	Speed	25 kph
25.5 fps	Velocity	15.5 m/s
2.35 sec	Time	2.35 sec

The grading committee will not round your answers for you or check your answer beyond the values stated above.

Answers given as a range (i.e.: "45-55 deg" or "10-12 inches", etc) are prohibited, and will be marked wrong.

All numeric answers must include the proper units (mph, degrees, feet, etc).

Unless otherwise stated in a particular question or with given information, a 60/40 front/rear weight distribution will be assumed for the vehicles described in the exam.

Approved List of Calculators for Use by Candidates when taking the ACTAR Accreditation Exam

Effective January 1, 2022

To protect the integrity of the accreditation exam, ACTAR limits the types of calculators that may be used by candidates during the exam.

Electronic devices (calculators) approved for use by candidates taking the accreditation examination include only those devices listed below.

No exceptions or substitutions are allowed.

Casio: All fx-115, fx-260, fx-300 and fx-991 models
(Any Casio calculator **must** have fx-115, fx-260, fx-300 or fx-991 in its model name.)

Hewlett Packard: The HP 33s and HP 35s models, but **no others**.

Texas Instruments: All TI-30X and TI-36X models
(Any Texas Instruments calculator **must** have "TI-30X" or "TI-36X" in its model name.)

Sharp: EL-531WB (BL or BK).
Any Sharp calculator **must** contain EL-531WB in its model name.

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IMPORTANT ADDENDUM TO EXAMINATION PREPARATION GUIDE

There **may** be some confusion among examination candidates concerning the use of foam core board or cork board as a diagraming aid. Foam core or cork board ***may*** be used following these guidelines.

If a candidate must use something other than the examination room tabletop to complete their drawing, they need to understand that it **will be surrendered** with their examination materials at the conclusion of the examination.

It is ACTAR's position that the diagram can be secured to the tabletop using adhesive tape and, that it is also possible to plot center of mass travel with a push pin or compass point without use of a substrate.

Candidates **must** understand that if they use something other than the tabletop there will be a permanent plot of the center of mass movement of the plotted vehicles on the substrate that **could** be used to *reconstruct* the departure angle(s) or other movement of the vehicles outside the examination room. This would be removal of examination materials. Hence, the reason that foam core or cork board material used for this purpose **must be surrendered** to the proctor at the end of the examination if it is used.