Conceptual Physics **NAME:**

Homework 1a: Classical Mechanics Homeworks are due usually a day after the corresponding textbook part/lecture is completed. Due dates will be announced in class. Multiple-choice problems will all be marked. **USE** the answer table for these problems. The rest of the homeworks will be marked for apparent completeness and some full-answer problems will/may be marked in detail. Make the full-answer solutions sufficiently detailed that the grader can follow your reasoning. Solutions will be posted eventually after the due dates. The solutions are intended to be (but not necessarily are) super-perfect and often go beyond full answers. For an argument or discussion problem, there really is no single right answer. The instructor's answer reflects his long experience in physics, but there could be objections to his arguments, assumptions, nuances, style, facts, etc.

NAME:

Answer Table for the Multiple-Choice Questions

	a	b	c	d	e		a	b	c	d	e
1.	O	O	O	O	O	26.	O	O	O	O	O
2.	O	O	O	O	O	27.	O	O	O	O	O
3.	O	O	O	O	O	28.	O	O	O	O	O
4.	O	O	O	O	O	29.	O	O	O	O	O
5.	O	O	O	O	O	30.	O	O	O	O	O
6.	O	O	O	O	O	31.	O	O	O	O	O
7.	O	O	O	O	O	32.	O	O	O	O	O
8.	O	O	O	O	O	33.	O	O	O	O	O
9.	O	O	O	O	O	34.	O	O	O	O	O
10.	O	O	O	O	O	35.	O	O	O	O	O
11.	O	O	O	O	O	36.	O	O	O	O	O
12.	O	O	O	O	O	37.	O	O	O	O	O
13.	O	O	O	O	O	38.	O	O	O	O	O
14.	O	O	O	O	O	39.	O	O	O	O	O
15.	O	O	O	O	O	40.	O	O	O	O	O
16.	O	O	O	O	O	41.	O	O	O	O	O
17.	O	O	O	O	O	42.	O	O	O	O	O
18.	O	O	O	O	O	43.	O	O	O	O	O
19.	O	O	O	O	O	44.	O	O	O	O	O
20.	O	O	O	O	O	45.	O	O	O	O	O
21.	O	O	O	O	O	46.	O	O	O	O	O
22.	O	O	O	O	O	47.	O	O	O	O	O
23.	O	O	O	O	O	48.	O	O	O	O	O
24.	O	O	O	O	O	49.	O	O	O	O	O
25.	O	O	O	O	O	50.	O	O	O	O	O

1. "Let's play *Jeopardy*! For $100, the answer is: It is the branch of physics dealing with the motions of bodies."

   What is _____, Alex?

   a) electromagnetism b) thermodynamics c) engineering d) mechanics
   e) chemical reactions

2. _____ is the only mechanics theory known before about 1900 and then thought to be the fundamental physics of motion. Nowadays we know it is an approximate theory valid for size scales much larger than atomic, size scales much smaller than cosmological, speeds much slower than the vacuum light speed, and gravity much weaker than black holes. Within its realm of validity it is a very accurate theory and, in fact, in the inner region of that realm no experimental discrepancies can be detected. The center of that realm—which might be tricky to defined exactly—can be called the classical limit. In the classical limit, one can describe the theory as an exact true emergent physics—and many would consider this the useful way to describe rather than as an approximate theory. As one departs form the classical limit, the theory progressively becomes more and more approximate and eventually becomes inadequate as a theory of motion.

   a) Classical mechanics b) Quantum mechanics c) Quantum field theory
   d) Relativistic physics e) Aristotelian physics

3. "Let's play *Jeopardy*! For $100, the answer is: The branch of mathematics concerned with shapes in space and the properties of space."

   What is _____, Alex?

   a) real analysis b) number theory c) calculus d) algebra e) geometry

4. The geometry of everyday life 3-dimensional space and a vast realm beyond everyday life 3-dimensional space is:

   a) hyperspherical. b) hyperbolic. c) Euclidean. d) curved. e) very curved.

5. The 2-dimensional surface of a sphere is not a flat space (i.e., not a Euclidean 2-dimensional space). One sign of this is that lines parallel at an equator:

   a) never meet. b) meet at the poles. c) meet 3 times.
   d) diverge from each other away from the equator. e) meet at the equator.

6. "Let's play *Jeopardy*! For $100, the answer is: It is the vector quantity specifying position relative to some origin. It has length which is the straightline distance from the origin to the position and a direction which is the direction from the origin to the position."

   What is _____, Alex?

   a) displacement b) velocity c) acceleration d) force e) time

7. You are in Las Vegas at the intersection of the Strip and Tropicana (where the MGM Grand, New York, New York, Excalibur, and Tropicana are). You go about **1 mile north** on the east side of the Strip to the Harley-Davidson Cafe, cross the Strip to the west side, and go about **half a mile south** to the Monte Carlo and there lose **most** of your of $100 stake at the roulette table.

   a) Your total travel distance is about **1.5 miles**, total displacement about **1 mile north**, and you have **more** than $50 left.
   b) Your total travel distance is about **1.5 miles**, total displacement about **0.5 miles north**, and you have **more** than $50 left.
   c) Your total travel distance is about **1.5 miles**, total displacement about **0.5 miles north**, and you have **less** than $50 left.
   d) Your total travel distance is about **1.5 miles**, total displacement about **1.5 miles north**, and you have **more** than $50 left.
   e) Your total travel distance is about **0.5 miles**, total displacement about **1.5 miles north**, and you have havn't got **bus fare** left.

8. A system exhibiting a periodic motion (i.e., a repeating motion where the repetitions take equal amounts of time) can be used as a _____. Some physical theory is needed to guarantee that the motion is periodic.

a) motion sensor b) meter stick c) clock d) crock e) hourglass

9. You have just traveled the back roads from Knoxville to Nashville. Your average speed was 60 mi/h, but you occasionally hit an instantaneous speed of 130 mi/h. (Could be you're hauling white lightning.) Your odometer travel distance is 250 miles. How long have you been on the road?

   a) 1/4 hours. b) 10 hours. c) 4.17 hours. d) 6 hours. e) about 2 hours.

10. You have just traveled 400 km on a trip to Knoxville and back. Knoxville is due east of your starting point. It took 8 hours. Your average **VELOCITY** (with velocity definitely meaning a vector here) was:

    a) 0 km/h with an indeterminate direction. b) 50 km/h west. c) 100 km/h east.
    d) 200 km/h west. e) 400 km/h north.

11. "Let's play *Jeopardy*! For $100, the answer is: It is the rate of change of velocity with respect to time. It is important to note that it is a vector and since velocity is a vector, the quantity is non-zero if velocity changes in either or both magnitude and direction."

    What is _____, Alex?

    a) time b) force c) displacement d) velocity e) acceleration

12. The magnitudes of displacement, velocity, and acceleration are usually called distance, speed, and:

    a) acceleration speed. b) deceleration. c) acceleration. d) accelmag.
    e) the unnameable.

13. A/An _____ is a physics defined frame of reference in which accelerations are caused by forces. In modern theory, this kind of frame is **NOT** accelerated relative to the local frame that participates in the mean expansion of the universe.

    a) accelerated frame b) rotating frame c) non-inertial frame d) inertial frame
    e) decelerated frame

14. A/An _____ is the cause of accelerations of bodies relative to inertial frames. In modern physics, we understand _____s to be themselved caused by fields which are continuous functions of space. Fields themselves are often caused by bodies nearby to the body being affected the _____ they cause. So one often speaks of _____ as relationships between bodies omitting as a simplification mention of the mediating field. This is especially true in classical mechanics discussions.

    a) force/forces. b) displacement/displacements c) velocity/velocities
    d) acceleration/accelerations e) momentum/momenta

15. Forces can cause accelerations relative to inertial frames or cancel other forces. Another manifestation (which actually follows from their property of causing acceleration) is that they can cause:

    a) velocity (without causing acceleration).
    b) mass.
    c) bodies to distort: i.e., flex, compress, stretch, etc.
    d) bodies to live
    e) bodies to rule.

16. "Let's play *Jeopardy*! For $100, the answer is: It is the quantity of resistance to the acceleration caused by a force. It is often called the quantity of matter, but this definition doesn't seem to add much to our understanding. It's true that the quantity in question is in many cases approximately proportional to the number of protons and neutrons in a body. If you consider number of protons and neutrons, the quantity of matter then the quantity in question is a measure of the quantity in question."

    What is _____, Alex?

    a) displacement b) velocity c) acceleration d) weight e) mass

17. "Let's play *Jeopardy*! For $100, the answer is: It is a mass-weighted mean position of an object."

    What is _____, Alex?

    a) center of weight b) the ordinary mean position c) acceleration d) mass
    e) center of mass

18. The center of mass (i.e., the actual physical position of the center of mass in space relative to the physical system it is the center of mass of) is:

    a) a function of the coordinate system.
    b) independent of the coordinate system.
    c) dependent on the coordinate system.
    d) both independent of and a function of the coordinate system.
    e) neither independent of nor a function of the coordinate system.

19. An object with symmetric in three dimensions about a geometric center has its center of mass at its:

    a) center of mass b) outer surface c) geometric center d) inner surface e) nowhere

20. Where is the center of mass of a hoop?

    a) At the end of the hoop.
    b) At the top of the hoop.
    c) At the left side of hoop.
    d) Nowhere since a center of mass must be physically inside an object to be a center of mass.
    e) On the axis of the hoop at the geometrical center of the hoop.

21. "Let's play *Jeopardy*! For $100, the answer is: If one hangs a rigid object from a freely turning pivot point and lets it come to stable static equilibrium, the center of mass is directly below the pivot point. Thus, center of mass can be found from the intersection of two lines through the object that start at two points used as pivot points and that go in the direction through the object that was downward when each of the points was the pivot point. The method fails if the two pivot points and the center of mass happen to be collinear."

    a) What is an **EMPIRICAL** method for finding gravitational torque, Alex?
    b) What is a **THEORETICAL** method for finding gravitational torque, Alex?
    c) What is gravitational torque, Alex?
    d) What is a center of mass, Alex?
    e) What is an **EMPIRICAL** method for finding the center of mass of a rigid object, Alex?

22. "Let's play *Jeopardy*. For $100, the answer is: The branch of physics that explains motion and acceleration in terms of forces and masses."

    What is _____, Alex?

    a) kinematics b) dynamics c) statics d) economics e) cinematics

23. How many laws of motion did Newton posit?

    a) 1. b) 2. c) 3. d) 4. e) 5.

24. Newton's 1st law is.

    a) **PHYSICALLY INDEPENDENT** of the other two laws of motion and **CANNOT** be dispensed with as an axiom of Newtonian physics.
    b) **PHYSICALLY INDEPENDENT** of the other two laws of motion, but nonetheless it **CAN** be dispensed with as an axiom of Newtonian physics.
    c) actually a **SPECIAL CASE** of the **2ND LAW**. The case when the net force is zero. Therefore logically we need only two laws of motion. Perhaps for clarity Newton formulated his explicit 1st law and perhaps for the same reason physicists have retained it.
    d) actually a **SPECIAL CASE** of the **3RD LAW**. The case when the net force is zero. Therefore logically we need only two laws of motion. Perhaps for clarity Newton formulated his explicit 1st law and perhaps for the same reason physicists have retained it.
    e) is **INCORRECT**, but is kept in the books for historical reasons.

25. Newton's 2nd law is:

    a) $m = \vec{F}_{\text{net}}\vec{a}$.
    b) $\vec{a} = m\vec{F}_{\text{net}}$.
    c) $\vec{F}_{\text{net}} = m\vec{a}$.
    d) For every force there is an equal and opposite force.
    e) For every acceleration there is an equal and opposite acceleration.

26. "Let's play *Jeopardy*! For \$100, the answer is: The mass-weighted average position of a system of particles: a system being any specified set of material mass elements. This position's acceleration obeys $\vec{F}_{\text{net}} = m\vec{a}$, where $\vec{F}_{\text{net}}$ is the net force (and also the net external force) acting on the system."

    What is the _____, Alex?

    a) center b) bottom end c) top end d) left end e) center of mass

27. If you know nothing about the internal forces of a body and only know the net external force that acts on the body and not where on the body the particular external forces act, then, by itself, Newton's 2nd law for a non-point mass only allows you to predict:

    a) the **VELOCITY** of the body.
    b) the **VELOCITY** of the center of mass of the body. You can know nothing about internal motions of the body or its rotational behavior.
    c) the **ACCELERATION** of the top point of the body.
    d) the **ACCELERATION** of the bottom point of the body.
    e) the **ACCELERATION** of the center of mass of the body. You can know nothing about internal motions of the body or its rotational behavior.

28. The base SI unit of force is the:

    a) farad (F); $1\,\text{F} = 1\,\text{kg}\,\text{m/s}^2 \approx 0.22481\,\text{lb} \approx 1/5\,\text{lb}$.
    b) henry (H); $1\,\text{H} = 1\,\text{kg}\,\text{m/s}^2 \approx 0.22481\,\text{lb} \approx 1/5\,\text{lb}$.
    c) watt (W); $1\,\text{W} = 1\,\text{kg}\,\text{m/s}^2 \approx 0.22481\,\text{lb} \approx 1/5\,\text{lb}$.
    d) joule (J); $1\,\text{J} = 1\,\text{kg}\,\text{m/s}^2 \approx 0.22481\,\text{lb} \approx 1/5\,\text{lb}$.
    e) newton (N); $1\,\text{N} = 1\,\text{kg}\,\text{m/s}^2 \approx 0.22481\,\text{lb} \approx 1/5\,\text{lb}$.

29. If Newton's 3rd law is true, why then does anything accelerate at all?

    a) The equal and opposite forces **DO NOT** have to be on the same body.
    b) The equal and opposite forces **DO** have to be on the same body.
    c) Nothing moves at all as Parmenides argued in the 5th century BC. Motion is but seeming. Anyway Parmenides seems to have been a pretty smart guy since he's credited with the spherical Earth theory and the discovery that the Moon shines by reflected light.
    d) Acceleration has nothing do with forces.
    e) Forces have nothing do with acceleration.

30. Why do internal forces not affect the center of mass acceleration of a system? Because:

    a) they cancel out in threesomes. b) they are all zero. c) we just ignore them. d) they cancel out pairwise. e) the external force cancels them out.

31. "Let's play *Jeopardy*! For \$100, the answer is: Laws that prescribe forces for physical systems. They must exist independent of Newton's 3 laws of motion in order for Newtonian physics to be useful."

    What are _____, Alex?

    a) Newton's 3 laws b) accelerations c) velocities d) force inequalities e) force laws

32. "Let's play *Jeopardy*! For \$100, the answer is: They have no size, but do have mass, and obey classical mechanics."

    What is _____, Alex?

    a) any solid object b) quantum mechanical particles c) classical point particles
    d) any blob of fluid e) any blob of gas

33. The area of physics dealing with **ONLY** cases of balanced forces (or equilibrium) is called:

    a) statics. b) dynamics. c) kinematics. d) kinesiology. e) cinema.

34. "Let's play *Jeopardy*! For \$100, the answer is: Stable, unstable, neutral, and metastable."

    What are _____, Alex?

    a) forces b) disequilibria c) equilibria d) laws of motion e) horses

35. A uniform pillar of density ρ, height h, and horizontal area A has normal force _____ at a height y above the ground.

    a) $(h-y)A\rho$ b) $yA\rho$ c) $(y/A)\rho$ d) $(h-y)/A]\rho$ e) $1/(yA\rho)$

36. A 50 N net force gives a brick an acceleration of 5 m/s. What net force is need to give it an acceleration of 10 m/s?

    a) 50 N. b) 5 N. c) 10 N. d) 200 N. e) 100 N.