Charles Darwin University

Final Examination

Family Name	
Given Name/s	
Student Number	
Teaching Period	Semester 2, 2017

SPH141 – Concepts of Physics	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

The examination has **twelve** questions. Please answer **ALL** questions.
Note that all questions **ARE NOT** of equal value.
The total marks of this examination are **55** marks.

EXAM CONDITIONS

<u>You may begin writing from the commencement of the examination session.</u> The reading time indicated above is provided as a guide only.

This is a RESTRICTED OPEN BOOK examination

Any non-programmable calculator is permitted

One A4 sheet of handwritten double-sided notes permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 20 Page Book

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Part 1 (17 marks)

1. Astronauts on our moon must function with acceleration due to gravity of 0.170g.

    (a) If an astronaut can throw a certain wrench 12.0m vertically upward on earth, how high could he throw it on our moon if he gives it the same starting speed in both places? (3 marks)

    (b) How much longer would it be in motion (going up and coming down) on the moon than on earth? (3 marks)

2. An astronaut in space cannot use a scale or balance to weigh objects because there is no gravity. But she does have a device to measure distance and time accurately. She knows that her own mass is 78.4kg, but she is unsure of the mass of a large gas canister in the airless rocket. When this canister is approaching her at 3.50 m/s, she pushes against it, which slows it down to 1.20m/s (but does not reverse it) and gives her a speed of 2.40 m/s.

    (a) What is the mass of this canister? (5 marks)
    (b) How much kinetic energy is 'lost' in this collision? (2 marks)

3. An astronaut holds two small aluminium spheres, each having mass 0.0250kg, 80.0cm apart. Each sphere carries a charge of +4.00 µC.

    (a) What is the repulsive force between the spheres? (2 marks)

    (b) What is the acceleration of each sphere the moment after the astronaut releases them? The astronaut is in airless environment; friction effect can be ignored. (2 marks)

Part 2 (11 marks)

4. The driver of an 1800kg car (including passengers) travelling at 23.0 m/s slams on the brakes, locking the wheels on the dry pavement. The coefficient of kinetic friction between rubber and dry concrete is typically 0.700.

    (a) Use the work-energy principle to calculate how far the car will travel before stopping. (3 marks)

    (b) How far will the car travel if it were going twice as fast? (3 marks)

    (c) What happened to the car's original kinetic energy? (1 marks)

5. A container ship is travelling westward at a speed of 5.00m/s. The waves on the surface of the ocean have a wavelength of 40.0m and are travelling eastward at a speed of 16.5m/s.

    (a) At what time interval does the ship encounter crests of a wave? (2 marks)

    (b) At what time intervals will the ship encounter wave crests if it turns around and heads eastward at a speed of 5.00m/s? (2 marks)

Part 3 (6 marks)

6. You can design a hydraulic lift for an automobile garage. It will consist of two oil-filled cylindrical pipes of different diameter. A worker pushes down on a piston at one end, raising the car on a platform at the other end. (See Figure below)
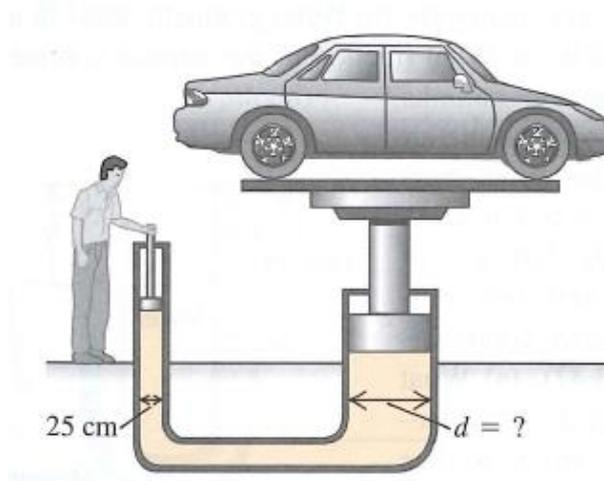
(Figure was taken from College Physics, by H Young *et al*)

To handle a full range of jobs, you must be able to lift cars up to 3500kg, plus the 500kg platform on which they are parked. To avoid injury to your workers, the maximum amount of force a worker should need to exert is 100N.

(a) What should be the diameter of the pipe under the platform? (4 marks)

(b) If the worker pushes down with a stroke 55cm long, by how much will he raise the car at the other end? (2 marks)

Part 4 (3 marks)

7. A parallel-sided plate of glass having a refractive index of 1.60 is in contact with the surface of water in a tank. A ray coming from above makes an angle of incidence of 32.0° with the top surface of the glass. What angle does this ray make with the normal in the water?

Part 5 (6 marks)

8. What is the amount of heat energy entering your skin when it receives the heat energy released by the following:

(a) 25.0g of steam initially at 100° C that cools to 34.0° C? (3 marks)

(b) 25.0g of water initially at 100° C that cools to 34.0° C? (2 marks)

(c) What do these results tell you about the relative severity of steam and hot-water burn? (1 marks)

Given that C_{water}=4.19kJ/(kg K), $L_{v(water)}$=2.256×10^{6}J/kg

Part 6 (3 marks)

9. Calculate the (a) maximum and (b) minimum value of resistance that can be obtained by combining resistors of 31 Ω, 45 Ω and 51 Ω.

Part 7 (3 marks)

10. A steel cable with cross-sectional area of 3.00cm^2 has an elastic limit of 2.40×10^8Pa. Find the maximum upward acceleration that can be given to a 1200kg elevator supported by the cable if the stress is not to exceed one-third of the elastic limit.

Part 8 (6 marks)

11. A small particle has charge -5.00 µC and mass 2.00×10^{-4}kg. It moves from point A, where the electric potential is V_A = +200V, to point B, where the electric potential is V_B = +800V. The electric force is the only force acting on the particle. The particle has speed 5.00m/s at point A. What is its speed at point B? Is it moving faster or slower at B than at A? Explain. (3 marks)

12. A particle with mass 0.03kg and charge +5 µC enters a region of space where there is a magnetic field of 1 Tesla that is perpendicular to the velocity of the particle. When the particle encounters the magnetic field, it experiences an acceleration of 12m/s^2. What is the speed of the particle when it enters the magnetic-field region? (3 marks)