Physics 3AB

Motion and Forces
Test Two
2013

Name:	Mark: / 54 = %

Notes to Students:

- You must include **all** working to be awarded full marks for a question.
- Marks will be deducted for incorrect or absent units and answers stated to an incorrect number of significant figures.
- **No** graphics calculators are permitted – scientific calculators only.

Question 1 **(12 marks)**

A Space Shuttle mission was in a circular orbit 3.00×10^2 km above the surface of the Earth.

(a) Determine the value of the gravitational field strength at this position.

(3 marks)

(b) Dr Andy Thomas, a famous Australian astronaut, was on this Shuttle with a mass of 78.0 kg. What was his weight whilst orbiting the Earth at that altitude?

(3 marks)

(c) Explain why Dr Thomas experienced 'weightlessness' whilst in orbit about the Earth.

(2 marks)

(d) Using your knowledge of contexts of motion, state how **you** could experience 'weightlessness' at or near the Earth's surface.

(1 mark)

(e) Does the shuttle need to produce a force from its rockets to keep it moving at constant speed? Assuming negligible air resistance, explain.

(3 marks)

Question 2 **(3 marks)**

A fork lift truck as shown in the adjacent photo is a vehicle used to lift and place heavy loads in a warehouse.

Typically loads can have a mass of up to 1.5 tonnes.

Explain, using the diagram, why the rear section of the truck behind the driver (shown by the arrow) is made from a massive block of steel as a fundamental safety design feature.

Question 3 **(5 marks)**

Geoff who is 70.0 kg steps into a lift on the ground floor of a twenty-story building.

(a) Draw a force diagram in the space below that shows the forces acting on Geoff as he stands in the lift.

(2 marks)

(b) The lift then accelerates upwards at 2.50 ms^{-2}. Calculate Geoff's apparent weight for this situation.

(3 marks)

Question 4 **(9 marks)**

With the recent landing of the unmanned roving vehicle Curiosity on Mars there has been a lot of interest in the planet. The mass of Mars is 6.46×10^{23} kg and the mean distance between it and the Sun is 2.28×10^{11} m.

(a) Calculate the gravitational force of the Sun acting on Mars.

(3 marks)

(b) Assuming Mars has a circular orbit calculate its circumferential speed.

(3 marks)

(c) Calculate the time it takes Mars to complete one orbit about the Sun.

(3 marks)

Question 5 **(8 marks)**

A moon of Jupiter makes a complete revolution about Jupiter in 1.53×10^5 s. Its orbit can be considered as a circle of radius 4.21×10^8 m.

(a) Use this data to calculate the mass of Jupiter.

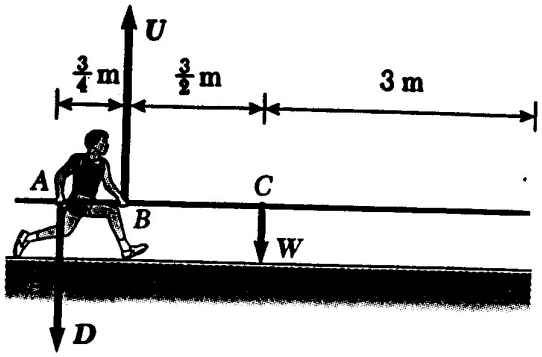
(5 marks)

(b) Determine the orbital speed of this moon in km s^{-1}.

(3 marks)

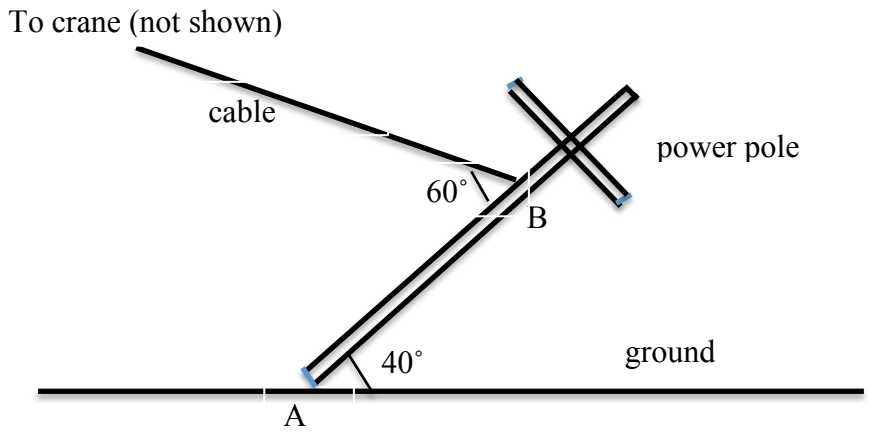
Question 6 **(5 marks)**

A pole vaulter holds his 6.00 m pole horizontally and in equilibrium by exerting an upward force **U** with his leading hand, which is 1.50 m behind the centre of mass of the pole, and a downward force **D** with his trailing hand which is located 0.75 m behind his leading hand. Assume that the centre of mass of the pole acts at its midpoint and the mass of the pole is 3.00 kg. Calculate the values of **U** and **D.**



Question 7 **(12 marks)**

Electricity engineers are using a crane to place a non-uniform power pole of length 14.0 metres and mass 648 kilograms into position next to a country road as shown in the diagram below.



The centre of mass of the pole is one third of its length from the base and the cable from the crane is attached at point B, 9.50 m from the base of the pole. If the crane has stopped lifting and the pole is at rest in the position shown in the diagram find,

(a) The tension in the cable

(4 marks)

(b) The frictional force on the pole at point A.

(3 marks)

(c) The force that the ground exerts on the pole at point A.

(5 marks)

END OF TEST