PHYSICS – problem solving exercises 2019

1. Kinematics: one-dimensional motion:
(1) 12.5 m
(2) (a) + 40 km/h (b) 40 km/h
(3) (a) 0 km/h (b) 40 km/h
(4) 3.75 ms
(5) 10 m/s
(6) 2.78 m/s^2
(7) -5 m/s^2
(8) 30 m/s
(9) 11 m/s
(10) 2.1 m/s^2
(11) no (1000 m are necessary)
(12) 80 m/s
(13) (a) 28.8 m (b) 2.4 s
(14) 16.2 m
(15) (a) 1.4 s (b) 9.8 m
(16) 11.25 m
(17) 20 m/s
(18) 5 m/s
(19) 26.3 m
(20) (a) 3.56 m/s^2 (b) 8.44 m/s
(21) (a) 27.3 m/s (b) 1.53 s

2a. Kinematics: one-dimensional and two-dimensional motion
(1) 40 m
(2) yes
(3) (a) 30 s (b) 300 m
(4) 48°
(5) (a) 3.0 s (b) 750 m (c) 30 m/s
(6) -20 m/s^2

2b. Kinematics: uniform circular motion + relative motion:
(7) (a) 90°, -90° (b) 0°, 180° (c) 90°, -90°
(8) (a) 7500 m/s (b) 8.0 m/s^2
(9) (a) 7.32 m (b) due west (c) due north
(10) (a) 126 km/s (b) 790 km/s^2 (c) v and a increase
(11) 4 m/s^2
(12) (a) +5 km/h (positive direction of the x axis) (b) -1 km/h (negative direction of the x axis)
(13) (a) (+80, -60) km/h (b) they are parallel
(14) (a) 13.2 m/s^2 eastward (b) 13.2 m/s^2 eastward
(15) 32 m/s
(16) 38 knots, 1.5° east of north

3. Dynamics: force and motion:

(1) 2.9 m/s^2

(2) (1.88, 0.68) N

(3) 2100 N

(4) 0 N

(5) (a) 5 kN (b) 3.3 m/s^2

(6) (a) 0 N (b) 15 kN

(7) (a) 0 N (b) 15 kN

(8) 19 kN

(9) (a) (-32.0, -20.8) N (b) 38.2 N, -147° (angle between the force and the positive part of x axis)

(10) (a) 42.5 N (b) 73.6 N (c) 5 m/s^2

(11) (a) 31.2 kN (b) 24.4 kN

(12) 241 N

(13) (a) 0.62 m/s^2 (b) 0.13 m/s^2 (c) 2.6 m

4. Dynamics: force, work, energy and power:

(1) magnitude of F_2 must increase

(2) (a) increases (b) decreases

(3) 18 kg

(4) both do the same work

(5) Petr: 50 W, Josef: 12.5 W

(6) 2500 N

(7) 62.5 W

(8) (a) 1556 J (b) gravitational force does no work

(9) 25.8 m/s

(10) (a) 28.3 m/s (b) speed decreases

(11) 32.4 J

(12) (a) 3765 J (b) 125.5 W

(13) P = 45.7 W, W = 19.2 kJ

(14) 125 kW

(15) (a) 10 MJ (helicopter), -7.5 MJ (gravitation), 2.5 MJ (net)
    (b) 7.5 MJ (helicopter), -7.5 MJ (gravitation), 0 J (net)

(16) 20 kN

(17) (a) -40 J (b) no work (c) no work

(18) (a) 11.9 kJ (b) -10.8 kJ (c) 1.1 kJ (d) 5.48 m/s

(19) 1.8 × 10^{13} J

(20) 89 N/cm

(21) (a) (4) (b) (1)

5a. Dynamics: momentum and collisions:
(1) (a) zero (b) positive (c) positive direction of the y axis
(2) (a) 10 kg.m/s (b) 14 kg.m/s (c) 6 kg.m/s
(3) 3 mm/s (3.10^{-3} m/s)
(4) 4.75 kg, 4.47 m/s
(5) 467 g
(6) 2 m/s
(7) (a) 4 kg.m/s (b) 8 kg.m/s (c) 3 J
(8) (a) 99 g (b) 1.86 m/s
(9) 4 kg, 14 kg
(10) 56 m/s
(11) (a) 0 m/s (b) 10 m/s

5b. Dynamics: impulse of force:
(12) 70 m/s
(13) 0.69 m/s
(14) 20 m/s
(15) (a) 42 N.s (b) 2100 N
(16) (a) 12 N.s, 4 N (b) -12 N.s, -6 N (c) -28 N.s, -14 N
(17) 0.5 s

6a. Dynamics: rotation:
(1) (a) 0.125 Hz (b) 0.79 rad/s (c) 3.7 m/s² (d) 4.7 m/s (e) 18.5 N (f) 55.5 J
(2) 5.0 m
(3) 3.5 kg.m²
(4) (a) 12 rad/s (b) 1.9 Hz (c) 324 J
(5) (a) 2 Hz (b) 0.5 s (c) 12.6 rad/s (d) 474 m/s²
(6) (a) 3.3 rad/s (b) magnitude of the force increases 4×
(7) 10.7 m/s
(8) 80 J

6b. Dynamics: torque and equilibrium:
(9) $\tau_1 = \tau_2 > \tau_3$
(10) 1.87 m
(11) 2 m
(12) 8.7 N
(13) −400 N, origin of the net force is 0.3 m left from the point P
(14) 2 N.m
(15) 1/3 m
(16) (a) 662 N (b) 572 N
(17) (a) 25 N (b) 75 N

6c. Dynamics: elasticity:
(18) 21 MPa
(19) 3.5 kN
(20) 30 kg
(21) 64 GPa
(22) tensile stress does not change
(23) 1.5 ΔL, 0.5 ε

7a. Gravitational force:

(1) (a) 1 mN (b) 16 mN (c) 36 mN
(2) 2640 km
(3) (a) $2F_G$ (b) $4F_G$

7b. Harmonic oscillations:

(4) 111 N/m
(5) 10.3 m/s^2
(6) 6.0 kg
(7) to change the length to $L/4$
(8) 3.2 Hz
(9) 6.3 cm
(10) 25.3 m
(11) (a) 0.5 s (b) 2 Hz (c) 18 cm
(12) (a) 10.1 N (b) 118.4 N/m
(13) (a) 28.3 m/s (b) 5330 m/s^2
(14) 4.2 m/s
(15) 37.8 m/s^2
(16) (a) 126.3 N/m (b) 17.8 cm
(17) (a) 20 cm (b) 0.94 m/s (c) 17.8 m/s^2